
Stepper Motor
Linear
Actuators

# Stepper Motor Linear Actuators: Product Summary

**Haydon Kerk Motion Solutions, Inc.** • www.haydonkerkpittman.com • Phone: 800 243 2715 • International: 203 756 7441

## Hybrid Linear Actuators

| Series | Size (square) | Configuration# | Stroke (mm) | | Max Force (N) | Travel/step (micron) |
|---|---|---|---|---|---|---|
| | | | C# | NC / EL# | | |
| **21000** | 21 mm (0.8-in) | C / NC / EL | 9 - 38.1 | Up to ≈ 200 | 2 - 44 | 1.5 - 40 |
| **28000** | 28 mm (1.1-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 250 | 15 - 90 | 3 - 50 |
| **35000** | 35 mm (1.4-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 300 | 50 - 220 | 1.5 - 50 |
| **43000** | 43 mm (1.7-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 400 | 100 - 220 | 1.5 - 50 |
| **57000** | 57 mm (2.3-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 500 | 300 - 890 | 4 - 50 |
| **87000** | 87 mm (3.4-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 500 | 400 - 2224 | 12.7 - 127 |

## Double Stack Hybrid Linear Actuators

| Series | Size (square) | Configuration# | Stroke (mm) | | Max Force (N) | Travel/step (micron) |
|---|---|---|---|---|---|---|
| | | | C# | NC / EL# | | |
| **21000** | 21 mm (0.8-in) | C / NC / EL | 9 - 38.1 | Up to ≈ 200 | 10 - 75 | 2.5 - 40 |
| **28000** | 28 mm (1.1-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 250 | 30 - 133 [A] | 3 - 50 |
| **35000** | 35 mm (1.4-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 300 | 50 - 220 [A] | 15.8 - 127 |
| **43000** | 43 mm (1.7-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 400 | 50 - 337 | 15.8 - 127 |
| **57000** | 57 mm (2.3-in) | C / NC / EL | 12.7 - 63.5 | Up to ≈ 500 | 150 - 890 [A] | 12.7 - 127 |

[A] Maximum force limited by bearing capabilities.

## Dual Action Actuators

| Size (square) | Torque (N-cm) | Linear Stroke (mm) | Max Force | Travel/step (micron) | Load Limits |
|---|---|---|---|---|---|
| 35 mm (1.4-in) | 12.7 | Up to 101.6† | 50 - 220 N (25 lbs) | 3 - 50 | 133 N (30 lbs) |
| 43 mm (1.7-in) | 13 | Up to 101.6† | 100 - 220 N (50 lbs) | 1.5 - 50 | 222 N (50 lbs) |

† Standard strokes: 25.4 mm (1-in.), 50.8 mm (2-in.) and 101.6 mm (4-in.).

## Can-Stack Linear Actuators

| Series | Ø Size | Configuration# | Stroke (mm) | | Max Force (N) | Travel/step (micron) |
|---|---|---|---|---|---|---|
| | | | C# | NC / EL# | | |
| **G4 19000** | 20 mm (.79-in) | C / NC / EL | 14 - 31 | Up to ≈ 150 | 12 - 50 | 25 - 100 |
| **G4 25000** | 26 mm (1-in) | C / NC / EL | 13 - 31 | Up to ≈ 150 | 20 - 90 | 12.7 - 100 |
| **G4 37000** | 36 mm (1.4-in) | C / NC / EL | 17 - 38 | Up to ≈ 150 | 30 - 260 | 12.7 - 100 |
| **LC15** | 15 mm (.59-in) | C / EL | 12.7 | Up to ≈ 60 | 7 | 20 |
| **(Z)20000** | 20 mm (.79-in) | C / NC / EL | 12.7 | Up to ≈ 150 | 3 - 35 | 25 - 100 |
| **(Z)26000** | 26 mm (1-in) | C / NC / EL | 12.7 - 31 | Up to ≈ 150 | 10 - 80 | 6 - 100 |
| **36000** | 36 mm (1.4-in) | C / NC / EL | 15.5 | Up to ≈ 150 | 15 - 160 | 3 - 100 |
| **46000** | 46 mm (1.8-in) | C / NC / EL | 23.1 | Up to ≈ 200 | 20 - 260 | 12.7 - 400 |

# Configurations = Captive / Non-captive / External Linear Lead-screws

## Drives

| | Type | Motor Leads | Input Voltage (VDC) | Current (RMS)/phase (I) | Microstepping Resolution |
|---|---|---|---|---|---|
| **40105** | Chopper | 4 | 20 - 40 | 2 | 2 |
| **44103** | Chopper | 4* | 24 - 28 | 1 | 8 |
| **DCS4020** | Chopper | 4 | 24 - 40 | 2 | 2 |
| **DCM4826X** | Chopper | 4 | 12 - 48 | 2.6 | 64 |
| **DCM8028** | Chopper | 4 / 6 / 8 | 20 - 80 *E* | 2.8 | 256 |
| **DCM8055** | Chopper | 4 / 6 / 8 | 20 - 80 *E* | 5.5 | 256 |

* 5V motors only. E = For Europe – the max. input voltage must be limited to 70 VDC (CE regulations).

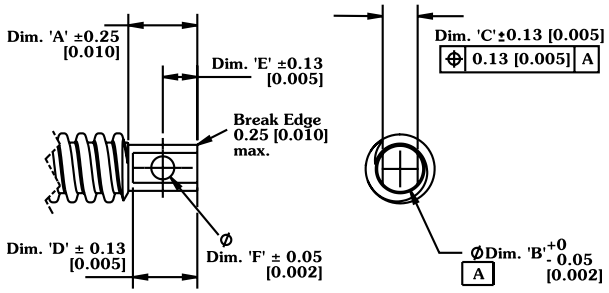
## Integrated Electronic Drive

| Series | Type | Input Voltage (VDC) | Programming | Connector | I/O inputs - I/O outputs |
|---|---|---|---|---|---|
| **IDEA DRIVE** | Chopper | 12 - 75 VDC | Graphic User Interface | USB/RS-485 | 8 opto-isolated |

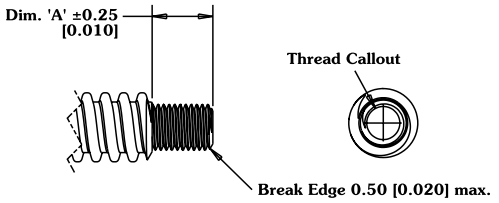
# Standard End Machining: Non-Captive and External Linear Actuators

Dimensions = mm [inches]

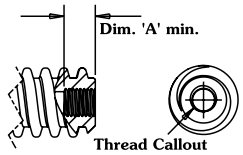
## Cross Drilled Hole



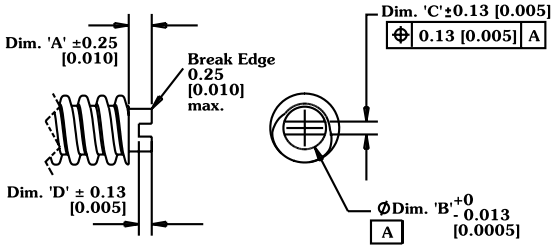

## Male Thread



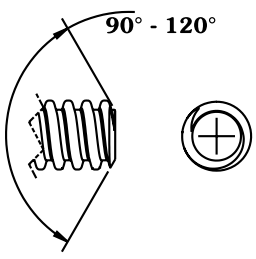

## Female Thread



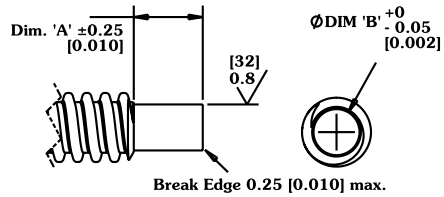

## Screwdriver Slot



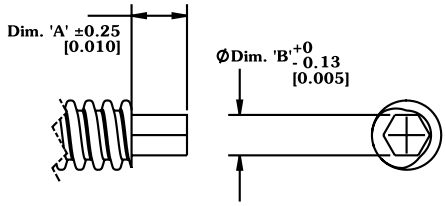

## Standard Break Edge



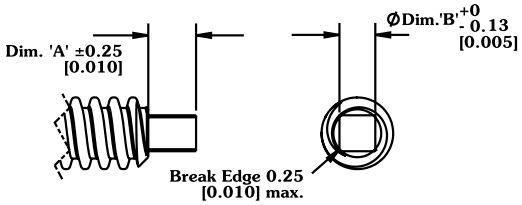

## Turned Journal



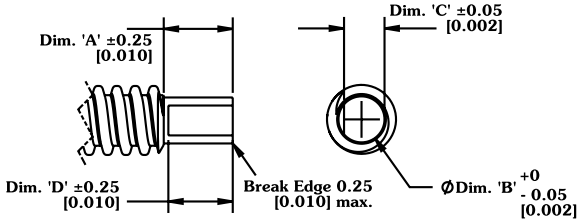

## Hex Drive End



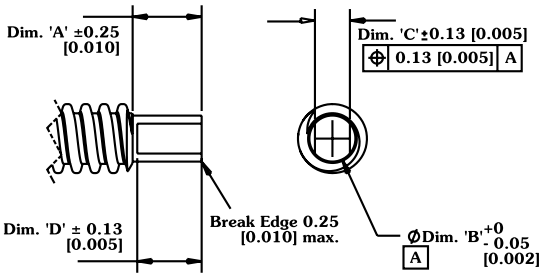

## Square End



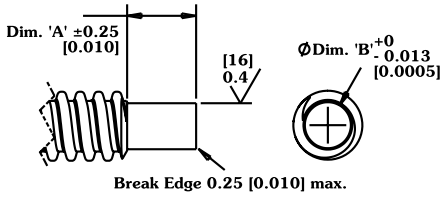

## Single Flat




## Double Flat




## Ground Journal



## Black Ice® Coating

Black Ice TFE coating is a hard coating that offers exceptional durability in all types of environments, with virtually any type of polymer lead-screw nut. Rather than acting as a dry lubricant, Black Ice TFE is an anti-friction coating whose surface properties displace the metal to which its is applied. Though it is not intended for use with metal or glass fiber reinforced nuts, Black Ice TFE is bonded securely to the surface of the lead-screw and can withstand abrasion from contamination, rigid polymer systems, fluid impingement and wash down applications.

## Haydon® Super Slick Greases

Haydon offers a wide selection of greases designed to meet any application requirements. Please contact Haydon Kerk Motion Solutions for assistance in selecting the most effective lubrication option.

| | Grease Type | Chemical Compat-ibility | Tempera-ture | Load Carrying Capacity | Comments | Cost Comparison |
|---|---|---|---|---|---|---|
| **HSS-17** | Synthetic Hydrocarbon | Good | -20°C to +125°C | High | Standard | $ |
| **HSS-03** | Polyolester | Good | -54°C to +150°C | Moderate | Can-Stack Standard | $ |
| **HSS-06** | Perfluoropolyether | Best | -65°C to +250°C | Moderate | Tough Environments | $$ |
| **HSS-16** | Perfluoropolyether | Better | -80°C to +204°C | Moderate | Vacuum compatible | $$$ |
| **HSS-20** | Perfluoropolyether | Best | -65°C to +250°C | Moderate | High Repeatability | $$$ |

### HSS-17

is a medium viscosity synthetic hydrocarbon grease thickened with lithium soap. It is fortified with EP (extreme pressure) modifiers to increase load carrying capabilities and TFE to increase lubricity and reduce friction. Rated temperature capacity is -20°C to +125°C.

### HSS-03

is a light viscosity, polyolester based grease thickened with PTFE. It is an economical alternative to premium PFPE (perfluoropolyether) types where low temperature performance is a primary requirement as it provides low starting torque.

### HSS-06

is a TFE thickened heavy viscosity perfluoropolyether grease. It is designed to operate in chemically harsh environments and provides excellent operating properties for light to medium loads. Rated temperature capacity is -65°C to +250°C. Standard on Hybrid Actuators.

### HSS-16

is a perfluoropolyether grease developed for use in vacuum environments good to $4x10^{-13}$ torr at 20°C. Rated temperature capacity is -80°C to +204°C.

### HSS-20

is an ultrafiltered version of HSS-06, meaning that the grease it put through a 'cleaning' process to remove any particles greater than 35 microns in size. It is designed for use when accuracy and repeatability are of utmost concern.

***Suppose you, as an engineer, are tasked to design a machine or part of a machine that requires precise linear positioning. How would you go about accomplishing this? What is the most straightforward and effective method?***

When students are trained in classic mechanical engineering, they are taught to construct a system using conventional mechanical components to convert rotary into linear motion. Converting rotary to linear motion can be accomplished by several mechanical means using a motor, rack and pinion, belt and pulley, and other mechanical linkages. The most effective way to accomplish this rotary to linear motion, however, is within the motor itself.

## First, What Exactly Is a Stepper Motor-Based Linear Actuator?

A linear actuator is a device that develops a force and a motion through a straight line. A stepper motor-based linear actuator uses a stepping motor as the source of rotary power. Inside the rotor, there's a threaded precision nut instead of a shaft. The shaft is replaced by a lead-screw. As the rotor turns (as in a conventional stepper motor), linear motion is achieved directly through the nut and threaded screw. It makes sense to accomplish the rotary to linear conversion directly inside the motor, as this approach greatly simplifies the design of rotary to linear applications. This allows high resolution and accuracy ideal for use in applications where precision motion is required.

## Basic Components

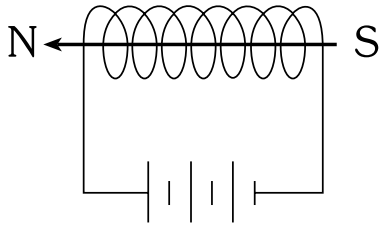
### Stepper Motor

Why use a stepper motor instead of a conventional rotary motor? Unlike other rotary motors, steppers are unique in that they move a given amount of rotary motion for every electrical input pulse. This makes steppers a perfect solution for use in positioning applications. Depending on the type of stepper motor, our motors can achieve resolutions from 18 rotational degrees per step to 0.9 rotational degrees per step. This unique "stepping" feature coupled with the characteristics of the lead-screw provides a variety of very fine positioning resolutions

### How Does the Stepper Motor Work?

Permanent magnet stepper motors incorporate a permanent magnet rotor, coil windings, and a steel stator capable of carrying magnetic flux. Energizing a coil winding creates an electromagnetic field with a NORTH and SOUTH pole as shown in figure 1.

*Figure 1. Magnetic field created by energizing a coil winding*




The stator conducts the magnetic field and causes the permanent magnet rotor to align itself to the field. The stator magnetic field can be altered by sequentially energizing and de-energizing the stator coils. This causes a "stepping" action and incrementally moves the rotor resulting in angular motion.

### "One-Phase On" Stepping Sequence

Figure 2 illustrates a typical step sequence for a simplified 2 phase motor. In step 1, phase A of the 2 phase stator is energized. This magnetically locks the rotor in the position shown, since unlike poles attract. When phase A is turned off and phase B is turned on, the rotor moves 90° clockwise. In step 3, phase B is turned off and phase A is turned on but with the polarity reversed from step 1. This causes another 90° rotation. In step 4, phase A is turned off and phase B is turned on, with polarity reversed from step 2. Repeating this sequence causes the rotor to move clockwise in 90° steps.

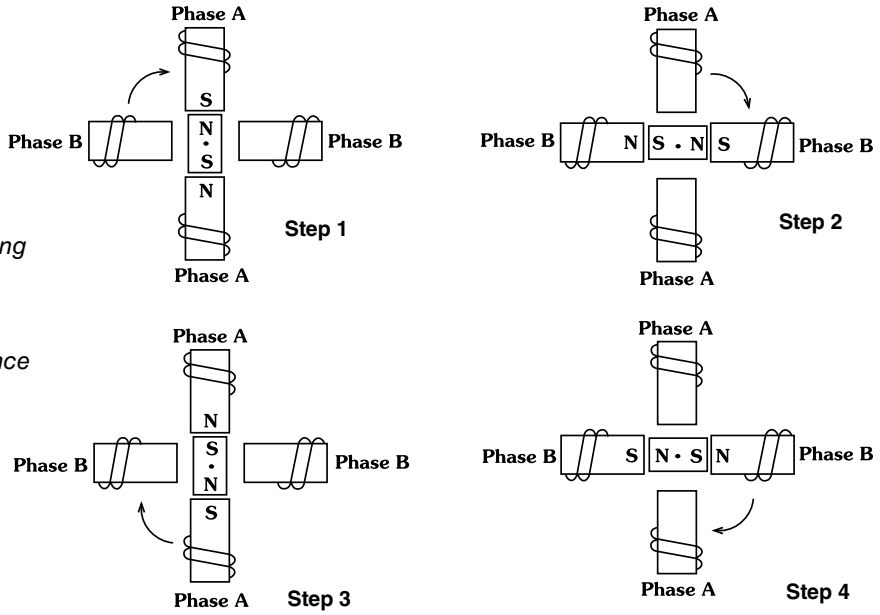



*Figure 2."One Phase On"stepping sequence for two phase motor "Two-Phase On" Stepping Sequence*

### "Two-Phase On" Stepping Sequence

A more common method of stepping is "two phase on" where both phases of the motor are always energized. However, only the polarity of one phase is switched at a time, as shown in Figure 3. With two phase on stepping, the rotor aligns itself between the "average" north and "average" south magnetic poles. Since both phases are always on, this method provides 41.4% more torque than "one phase on" stepping.

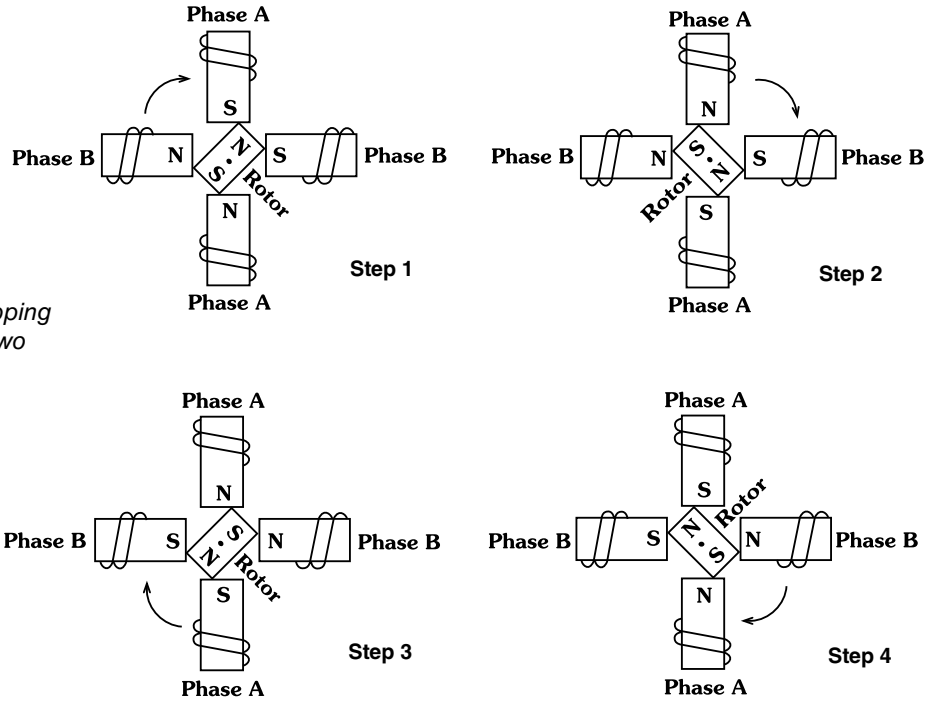


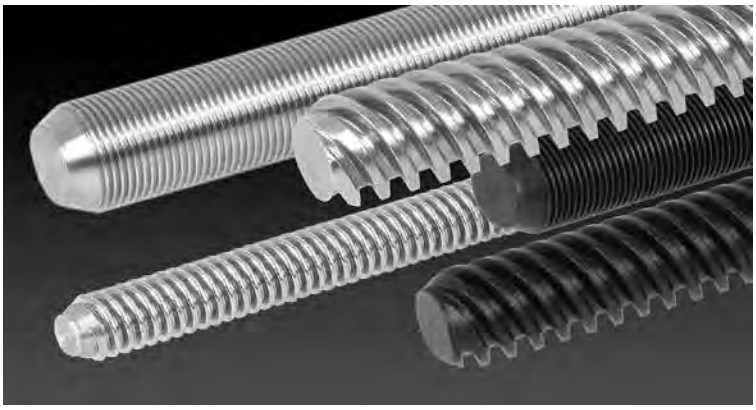

*Figure 3."Two Phase On"stepping sequence for two phase motor*

## Lead-screw

The acme lead-screw is a special type of screw that provides a linear force using the simple mechanical principle of the inclined plane. Imagine a steel shaft with a ramp (inclined plane) wrapped around it. The mechanical advantage (force amplification) is determined by the angle of the ramp which is a function of the lead, pitch, and diameter of the screw.

***Lead*** – The axial distance a screw thread advances in a single revolution
***Pitch*** – The axial distance measured between adjacent thread forms

The threads of the lead-screw allow a small rotational force to translate into a large load capability depending on the steepness of the ramp (the thread lead). A small lead (more threads per inch) will provide a high force and resolution output. A large lead (fewer threads) will provide a lower force, but a correspondingly higher linear speed from the same source of rotary power.



*Examples of different thread configurations: Finer lead threads will provide higher force but lower speeds; Coarse lead threads will provide higher speeds but lower force.*

## Integrated Nut

Of equal, if not greater importance to the lead-screw is the nut that drives the screw. This nut is often imbedded in the rotor of the stepping motor, which makes this actuator configuration unique from other rotary to linear techniques. The traditional nut material is a bearing grade bronze which lends itself to the required machining of the internal threads. Bronze is a traditional compromise between physical stability and lubricity. Compromise, however, is the key word since it excels at neither.

### *Friction Considerations*

A much better material for a power nut in the linear actuator is a lubricated thermoplastic material. With the evolution of new engineered plastics, the screw threads may now travel with a lower overall coefficient of friction. This is illustrated below in Figure 4.

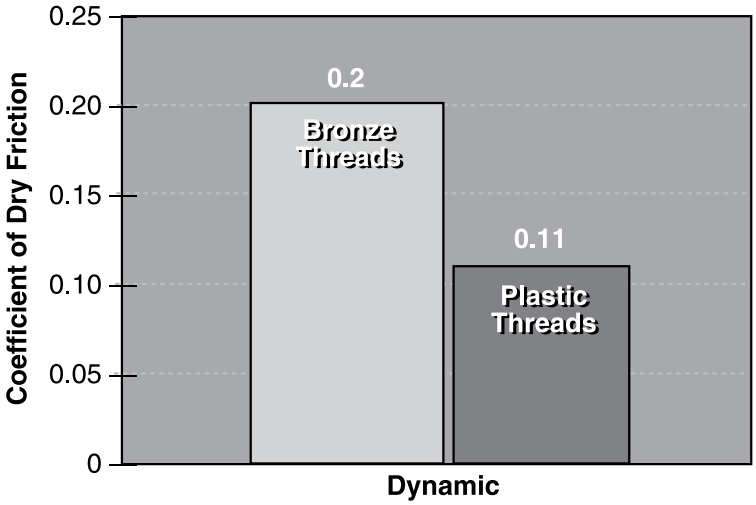



*Figure 4.*

***FRICTION EFFECTS***

*Comparative friction effects of stainless steel on select rotor materials*

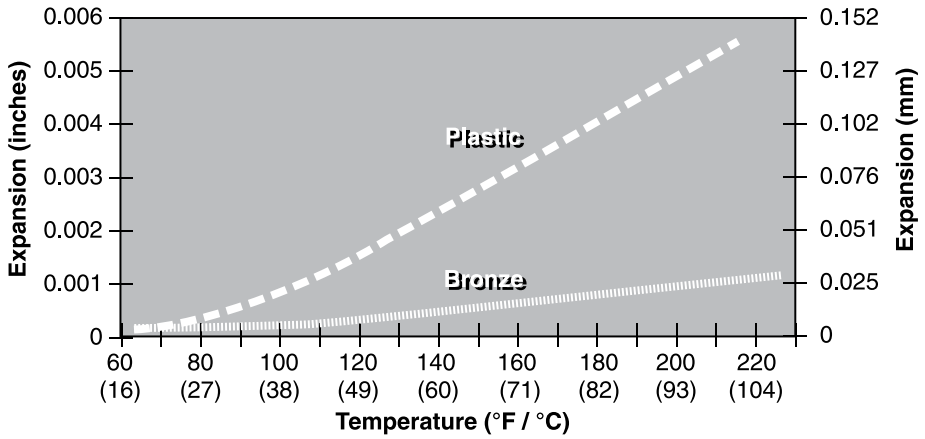
## Thermal Considerations

Given the data, it was clear that a plastic drive nut provides the lower coefficient of friction when compared with bronze. Unfortunately, as good as the plastic is for threads, it is not stable enough for the bearing journals of a hybrid motor, which are critical in the hybrid motor design. Under a continuous full load condition, plastic bearing journals can expand as much as 0.004", where brass will expand only 0.001". This is illustrated in Figure 5. In order to achieve the high performance characteristics of the stepper motor, the design must maintain a stator-to-rotor airgap of only a few thousandths of an inch. This tight design requirement demands thermally stable bearing journals.

*Figure 5.*

***THERMAL EFFECT***

*Linear thermal expansion for 1-inch (25.4 mm) samples*

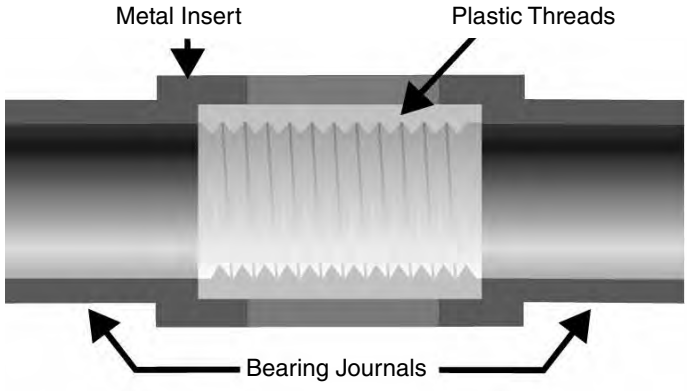



By injection molding plastic threads within a brass rotor assembly, both characteristics of low friction and high bearing journal stability is achieved (see figure 6).

*Figure 6.*

***POWER NUT CONFIGURATION***

*Embedded in Permanent Magnet Rotor*



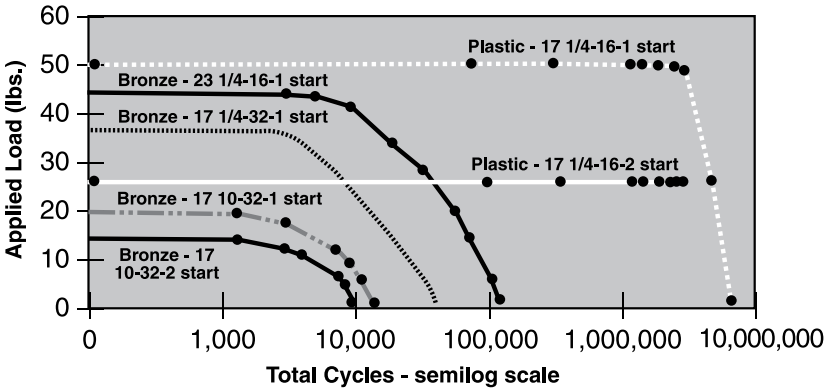

## Effects on Actuator Life

The result is a product with quiet operation, higher efficiencies, and higher life expectancies. Motor life is improved by 10 to 100 times over the traditional bronze nut configuration, as illustrated in the life test chart in figure 7.

*Figure 7.*

***LIFE TEST: BRONZE vs PLASTIC***

*Nuts used in Size 17 and 23 Hybrid Linear Actuators*



## Extending Actuator Life

With proper application consideration, Haydon linear actuators deliver up to 20 million cycles. Ultimately, motor fatigue and resultant life are determined by each customer's unique application.

There are some general guidelines that should be understood in order to insure maximum life. Ultimately, to determine an actuator's performance in a given system it's best to perform testing in the final assembly in "field conditions" or in a setting that closely approximates those conditions.

Since a stepper has no brushes to wear out, its life usually far exceeds that of other mechanical components of the system. If a stepper does fail there are certain components which are likely to be involved. Bearings and lead-screw/nut interface (in linear actuators) are typically the first components to experience fatigue. Required torque or thrust and operating environment are the factors which affect these motor components.

Extensive testing has shown that motor life increases exponentially with reduced operating loads. Environmental factors such as high humidity, exposure to harsh chemicals or gases, excessive dirt/debris, and heat will affect motor life. Mechanical factors in the assembly such as side loading of the shaft (linear actuators) or an unbalanced load (rotary motors) will also affect life.

Properly designing a system which minimizes these factors and also insuring the motor is operating within its electrical specifications will ensure maximum motor life. The first step in maximizing life is choosing a motor which has a safety factor of 2 or more. The second step is insuring the system is mechanically sound by minimizing side loading, unbalanced loads, and impact loads. Also insure techniques to allow effective heat dissipation. Air flow around the motor or mounting which provides some heat sinking are effective means to insure the motor operates at a safe temperature.

If these simple, yet effective guidelines are followed, the linear actuators will provide reliable operation over millions of cycles.

## Putting It All Together

Figure 8 below is a cross section drawing of a "captive" type linear actuator. Captive indicates that there is already an anti-rotation mechanism built into the actuator through the use of a splined "anti-rotation" shaft and a "captive sleeve." The "captive" configuration is ideal for use in precision liquid drawing/dispensing and proportional valve control. Other forms of linear actuators are "non-captive" and "external linear" as pictured in Figures 9 and 10.

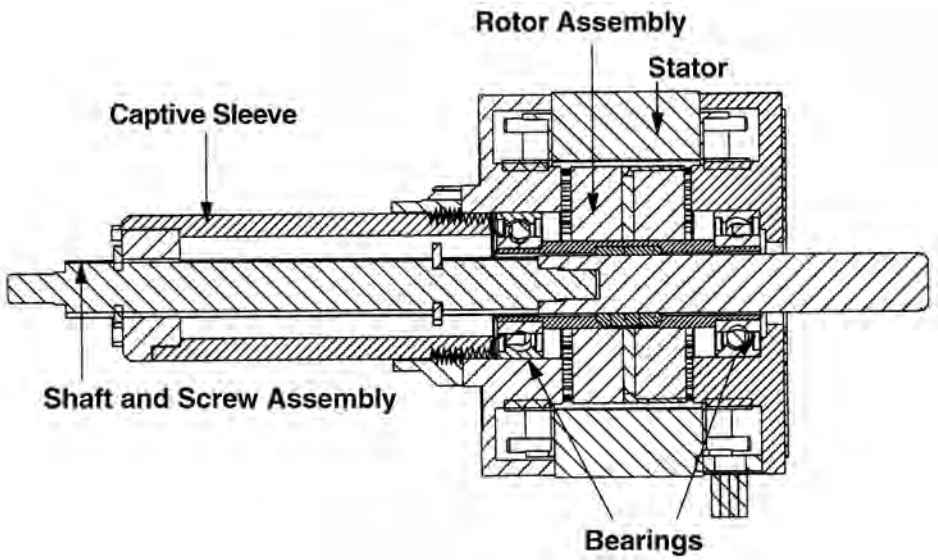



*Figure 8.*

***TYPICAL HYBRID LINEAR ACTUATOR***

*Captive linear stepping actuator*

*Figure 9.*

***HYBRID LINEAR ACTUATORS***

*Size 17 Series (1.7-in / 43 mm square) captive, non-captive and external linear, available in 1.8 and 0.9 rotational degrees per step.*

*Figure 10.*

***CAN-STACK LINEAR ACTUATORS***

*36000 Series (Ø 1.4-in / 36 mm) Captive, external linear, non-captive available in 15 and 7.5 rotational degrees per step.*

**All This Theory Is Good, But How Are They Sized?**

Sizing a linear actuator is quite easy once you understand the basic needs of the application. The following is the minimum information needed to begin sizing the proper device.

1) Linear force needed to move the load, expressed in Newtons (N)
2) Linear distance the load needs to be moved, expressed in meters (M)
3) Time required to move the load, expressed in seconds (s)
4) Table 1 (next page)
5) Performance curves illustrated in Haydon linear actuator catalogs

***Power Requirements***

The power required to meet the application is now calculated using the parameters above. This will allow the user to easily choose the correct motor framesize needed.

$$\text{P linear} = \frac{\text{(distance traveled in Meters) (force in Newtons)}}{\text{(Time to travel the distance in Seconds)}} = \text{watts}$$

Once the power is known in watts, choose the proper framesize of the actuator as listed in Table 1 (next page).

All stepper motor linear actuators require a drive to send the pulses to the motor. As seen in the table, the power for both an L/R drive and a chopper drive is listed. Most applications today use an electronic chopper drive. Unless the application is battery powered (as in a hand-held portable device), a chopper drive is highly recommended to get the maximum performance from the linear actuator.

***Table 1. Frame Sizes and Performance Based On Required Output Power***

| Hybrid Single Stack | | | | | |
|---|---|---|---|---|---|
| | | | | Max. Linear Power (watts) | |
| Series | Size | Max Force (N) | Linear Travel Per Step (micron) | L/R Drive | Chopper Drive |
| **21000** | 8 | 44 | 1.5 – 40 | 0.3 | 0.37 |
| **28000** | 11 | 90 | 3 – 50 | 0.27 | 0.51 |
| **35000** | 14 | 220 | 1.5 – 50 | 0 .59 | 1.5 |
| **43000** | 17 | 220 | 1.5 – 50 | 1.02 | 2.31 |
| **57000** | 23 | 890 | 4 – 50 | 1.47 | 6 |
| **87000** | 34 | 2224 | 12.7 – 127 | N/A | 21.19 |

| Hybrid Double Stack | | | | | |
|---|---|---|---|---|---|
| | | | | Max. Linear Power (watts) | |
| Series | Size | Max Force (N) | Linear Travel Per Step (micron) | L/R Drive | Chopper Drive |
| **21000** | 8 | 75 | 2.5 – 40 | N/A | 0.76 |
| **28000** | 11 | 133 | 3 – 50 | N/A | 1.14 |
| **35000** | 14 | 220 | 15.8 – 127 | N/A | 2.7 |
| **43000** | 17 | 337 | 15.8 – 127 | N/A | 4.62 |
| **57000** | 23 | 890 | 12.7 – 127 | N/A | 10.08 |

| Can-Stack | | | | | |
|---|---|---|---|---|---|
| | | | | Max. Linear Power (watts) | |
| Series | Size Ø (mm) | Max Force (N) | Linear Travel Per Step (micron) | L/R Drive | Chopper Drive |
| **G4 19000** | 20 | 50 | 25 – 100 | 0.17 | 0.35 |
| **G4 25000** | 26 | 90 | 12.7 – 100 | 0.26 | 0.53 |
| **G4 37000** | 36 | 260 | 12.7 – 100 | 0.44 | 0.66 |
| **15000** | 15 | 7 | 20 | 0.025 | 0.03 |
| **Z20000** | 20 | 35 | 25 – 100 | 0 .09 | 0.23 |
| **Z26000** | 26 | 80 | 6 – 100 | 0.18 | 0.48 |
| **36000** | 36 | 160 | 3 – 100 | 0.23 | 0.51 |
| **46000** | 46 | 260 | 12.7 – 400 | 0.55 | 1.13 |

### *Velocity*

After calculating the mechanical power needed to meet the application requirements, the linear velocity in inches per second is calculated using the following equation.

$$\text{Velocity linear} = \frac{\text{Required travel distance (in)}}{\text{Time to achieve travel (s)}} = \text{in / s}$$

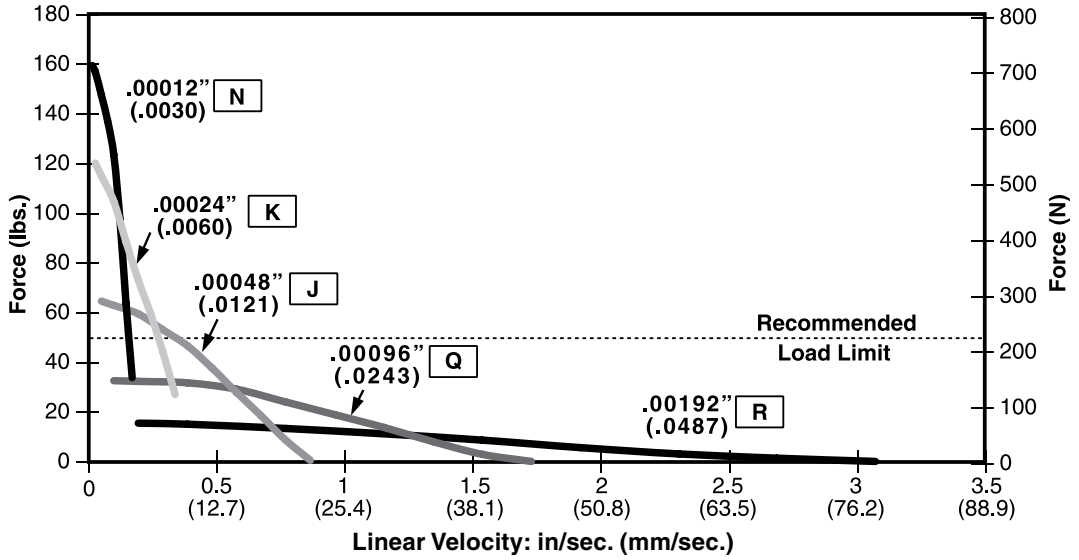
### Force vs Linear Velocity Curves

Once the required actuator framesize is determined and the linear velocity is calculated, the "force vs linear velocity curve" is used to determine the proper resolution of the actuator lead-screw.

*Figure 11.*

***FORCE vs LINEAR VELOCITY SIZE 17 SERIES 43000***

*Ø .218 (5.54 mm) lead-screw, Bipolar, Chopper Drive, 100% Duty Cycle*




### Actuator Life

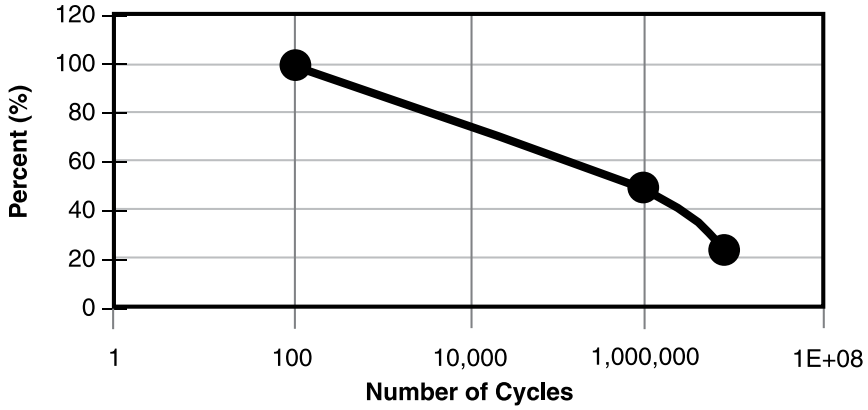
There are many variables that ultimately determine life of the actuator. The best way to predict life is through application testing, which is highly recommended.

There is, however, a first approximation technique that can help estimate this value. The stepper motor prime mover contains no brushes to wear out and also utilize precision long-life ball bearings. The main wear component is the power nut. The number of cycles can be summarized as a function of load, as illustrated in Figure 12 below.

*Figure 12.*

***% RATED LOAD vs NUMBER OF CYCLES***

*Cycles on a standard stroke actuator*




With proper application, Haydon linear actuators deliver up to 20 million cycles and Haydon rotary motors provide up to 25,000 hours of service. Ultimately motor fatigue and resultant life are determined by each customer's unique application. The following definitions are important for understanding motor life and fatigue.

**Continuous Duty:** Running a motor at its rated voltage.

**25% Duty Cycle:** Running a motor at double its rated power. The motor is "on" approximately 25% of the time. The motor generates about 60% more output than at rated voltage. Note, duty cycle is not related to the load placed on the motor. Also, there is a 50% reduction when using LC/LE15000 Series motors.

**Life:** A linear actuator's life is the number of cycles that the motor is able to move at a prescribed load and maintain step accuracy. Rotary motor life is the number of hours of operation. Life axis values should be halved for the LC/LE 15000 Series actuators.

**One Cycle:** A linear actuator's cycle consists of extending and retracting back to the original position.

***EXAMPLE #1***

***Application Requirements:***

| | |
|---|---|
| Required Force (lbs) = | 15 lbs |
| Required Travel (inches) = | 3 in |
| Time To Achieve Travel (sec) = | 6 sec |
| Desired Cycles = | 1,000,000 |
| Linear Velocity (in / sec) = | 3 in / 6 sec = 0.5 in / sec |

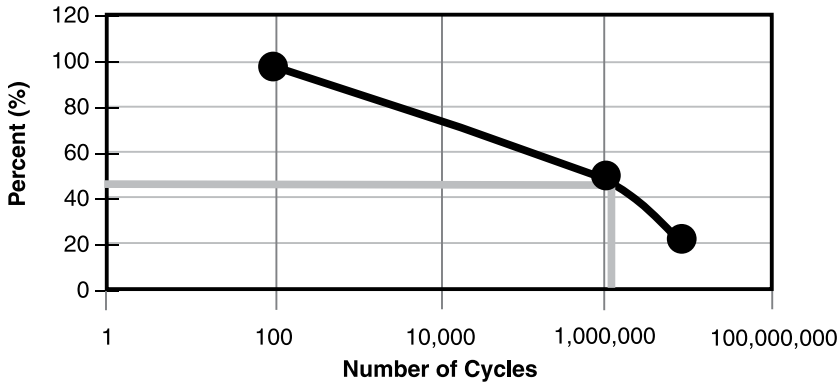
***Calculate the initial rated force based on required # of cycles:***

**Step 1:**
Refer to Figure 12 and determine the % wear after 1,000,000 cycles.
This is indicated with the blue line in Figure 13 below.

*Figure 13.*

***LIFE EXPECTANCY***

*Cycles on a standard stroke actuator*




**Step 2:**
As indicated in the chart, in order to get 1,000,000 cycles, a factor of 0.5 must be used when sizing the actuator. The initial rated force required in order to meet the load after 1,000,000 cycles is therefore…

15 lbs / 0.5 = 30 lbs

**Step 3:**
Convert lbs to Newtons (N)

30 lbs / (0.225 lbs / N) = 133 N

***Determine required travel in meters***

3 in x (0.0254 M / in) = 0.0762 M

***Choose the proper framesize actuator using the selector chart***

**Step 1:**
Determine the required linear mechanical power in watts

$P_{linear}$ = (133 N x 0.0762 M) / 6 sec = 1.7 N-M / sec = 1.7 watts

**Step 2:**
Use **Table 1** to determine the correct framesize actuator. As discussed earlier in the paper, most applications will use a chopper drive to supply the required input pulses to the stepper motor. The 43000 (Size 17 Hybrid) was chosen for this application, as highlighted in the **"Hybrid Single Stack"** section of Table 1.

| Hybrid Single Stack | | | | | |
|---|---|---|---|---|---|
| | | | | Max. Linear Power (watts) | |
| Series | Size | Max Force (N) | Linear Travel Per Step (micron) | L/R Drive | Chopper Drive |
| 21000 | 8 | 45 | 1.5 – 40 | 0.3 | 0.37 |
| 28000 | 11 | 90 | 3 – 50 | 0.27 | 0.51 |
| 35000 | 14 | 220 | 1.5 – 50 | 0 .59 | 1.5 |
| **43000** | **17** | 220 | 1.5 – 50 | 1.02 | **2.31** |
| 57000 | 23 | 880 | 4 – 50 | 1.47 | 6 |
| 87000 | 34 | 2200 | 12.7 – 127 | N/A | 21.19 |

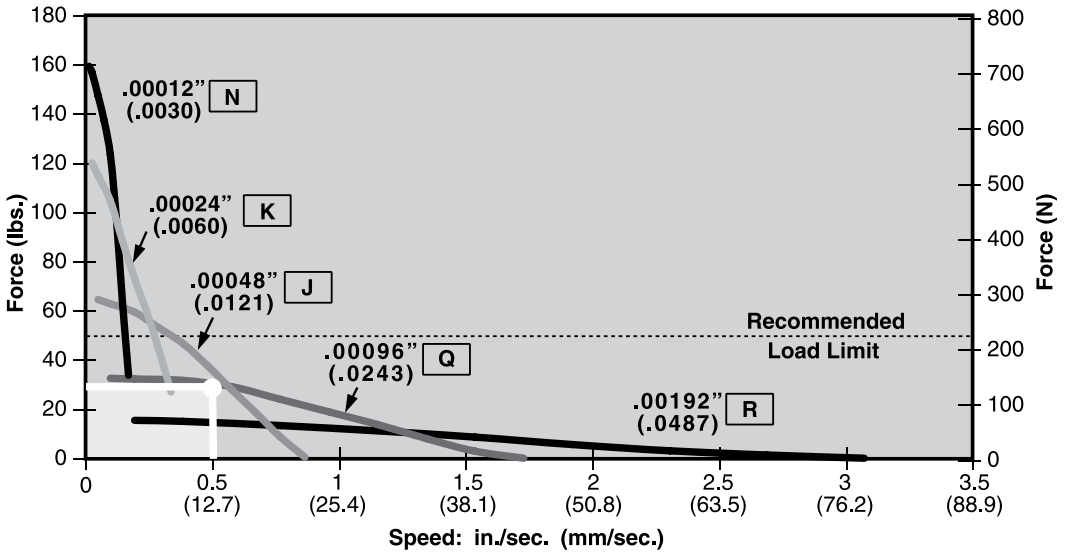
### Determine the proper resolution using the "Force vs Linear Velocity" chart

As determined by the life calculation performed above, an initial load of 30 lbs is to be moved at a velocity of 0.5 in / sec. The resulting lead-screw resolution required in the Size 17 hybrid motor is 0.00048" (J resolution), as indicated in figure 14 below.

*Figure 14.*

***FORCE vs LINEAR VELOCITY SIZE 17 SERIES 43000***

*Ø .218 (5.54 mm) lead-screw, Bipolar, Chopper Drive, 100% Duty Cycle*




### Verify selection by checking force at the required step rate

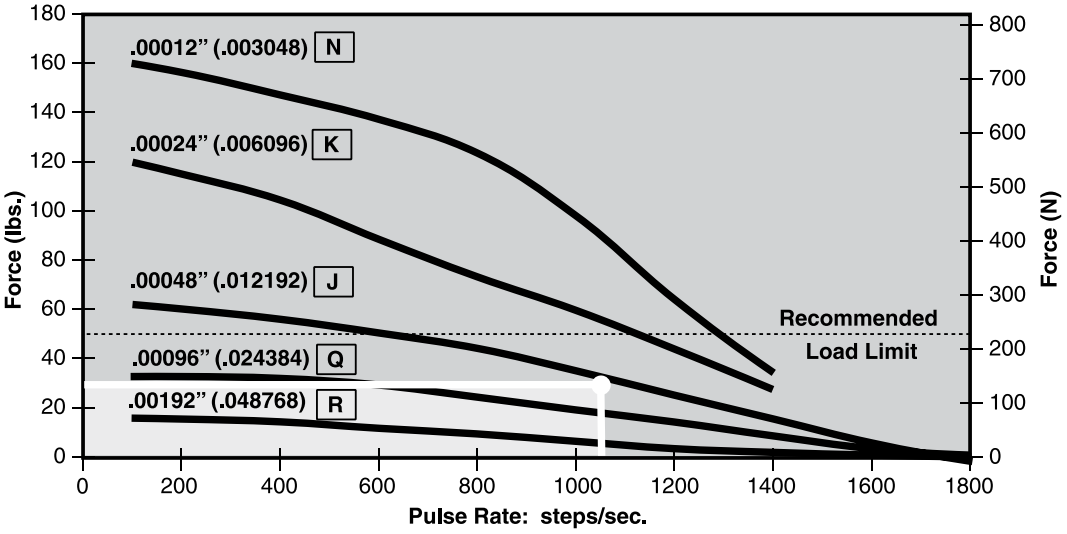
Earlier in the paper, it was discussed that the lead-screw advances based on the number of input steps to the motor. Haydon performance curves are expressed in both "in/sec" (as illustrated in Figure 14) and also in "steps / sec" (Figure 15 below). As an effective check, verify the selection by checking the force at the required step rate.

| | |
|---|---|
| Resolution chosen | 0.00048 in / step ("J" screw) |
| Req'd linear velocity | 0.5 in / sec |
| Req'd step rate | (0.5 in / sec) / (0.00048 in / step) = 1041 steps / sec |

*Figure 15.*

***FORCE vs PULSE RATE SIZE 17 SERIES 43000***

*Ø .218 (5.54 mm) lead-screw, Bipolar, Chopper Drive, 100% Duty Cycle*




Figures 14 and 15 are good illustrations of how the pulses to the stepper motor translate into linear motion through the lead-screw.

### *EXAMPLE #2*

Haydon Kerk Motion Solutions, Inc. offers a line of Double Stack Hybrid Actuators that are designed to meet the needs of higher speed applications. This next example illustrates a typical situation where higher speed is required to perform the motion.

All other application requirements with the exception of the move velocity is unchanged from Example #1.

***Application Requirements:***

| | |
|---|---|
| Required Force (lbs) = | 15 lbs |
| Required Travel (inches) = | 3 in |
| Time To Achieve Travel (sec) = | 3 sec (modified application requirement) |
| Desired Cycles = | 1,000,000 |
| Linear Velocity (in / sec) = | 3 in / 3 sec = 1.0 in / sec (modified linear velocity) |

***Calculate the initial rated force based on required # of cycles:***

**Step 1:**
Refer to Figure 10 and determine the % wear after 1,000,000 cycles. This is indicated with the blue line in Figure 11. This will be identical to that shown in Sizing Example #1 because the number of desired cycles didn't change.

**Step 2:**
As indicated in Figure 11, in order to get 1,000,000 cycles, a factor of 0.5 must be used when sizing the actuator. The initial force required in order to meet the load after 1,000,000 cycles is therefore…

15 lbs / 0.5 = 30 lbs *(Unchanged from Example #1)*

**Step 3:**
Convert lbs to Newtons (N)

30 lbs / (0.225 lbs / N) = 133 N *(Unchanged from Example #1)*

***Determine required travel in meters***

3 in x (0.0254 M / in) = 0.0762 M (*(Unchanged from Example #1)*

***Choose the proper framesize actuator using the selector chart***

**Step 1:**
Determine the required linear mechanical power in watts

$P_{linear}$ = (133N x 0.0762M) / 3s = 3.4 N-M / s = 3.4 watts *(This changed from 1.7 watts needed in Example #1)*

As shown from the result above, the required output power increased by 100% due to the application requirement change from a 6s Time to Achieve Travel (Example #1) to a 3s Time to Achieve Travel.

**Step 2:**
Assuming the mounting footprint is to remain unchanged (in this case, the Size 17 motor frame), using the Double Stack version of the actuator would easily meet the application requirements. This is highlighted in the **"Hybrid Double Stack"** section of **Table 1**.

| Hybrid Double Stack | | | | | |
|---|---|---|---|---|---|
| | | | | Max. Linear Power (watts) | |
| **Series** | **Size** | **Max Force (N)** | **Linear Travel Per Step (micron)** | **L/R Drive** | **Chopper Drive** |
| **21000** | 8 | 75 | 2.5 – 40 | N/A | 0.76 |
| **28000** | 11 | 133 | 3 – 50 | N/A | 1.14 |
| **35000** | 14 | 220 | 15.8 – 127 | N/A | 2.7 |
| **43000** | **17** | 337 | 15.8 – 127 | N/A | **4.62** |
| **57000** | 23 | 890 | 12.7 – 127 | N/A | 10.08 |

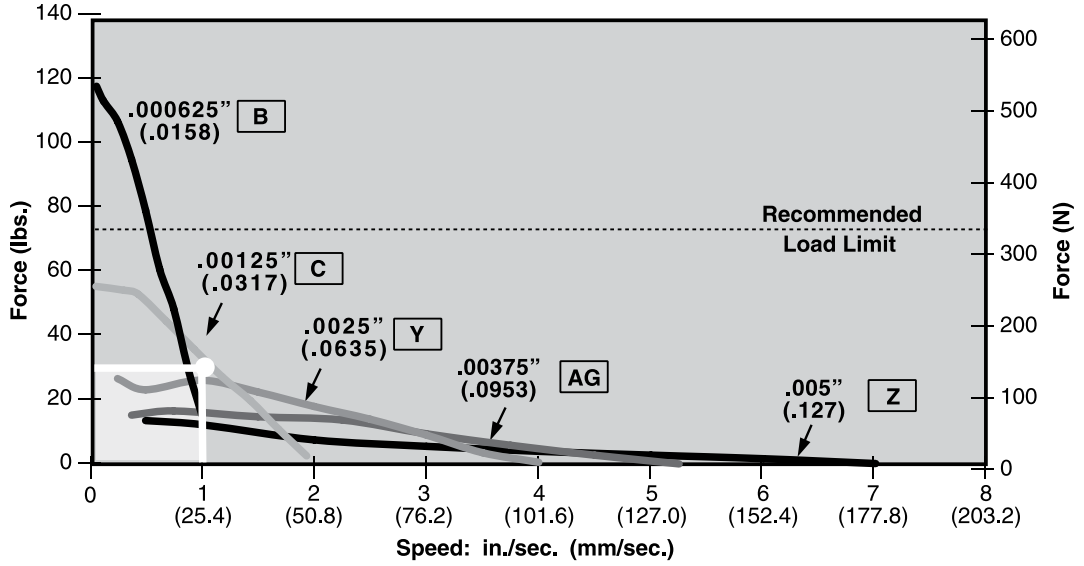
***Determine the proper resolution using the "Force vs Linear Velocity" chart***

As determined by the life calculation performed above, an initial load of 30 lbs is to be moved at a new velocity of 1.0 in/s. The intercept falls under curve "C". The resulting lead-screw resolution required in the Size 17 double stack hybrid motor is 0.00125" (C resolution), as indicated in Figure 16 below.

*Figure 16.*

***FORCE vs LINEAR VELOCITY SIZE 17 DOUBLE STACK SERIES 43000***

*Ø .250 (6.35 mm) lead-screw, Bipolar, Chopper Drive, 100% Duty Cycle*




***Verify selection by checking force at the required step rate***

As discussed earlier, Haydon motor performance curves are expressed in both "in/sec" and also in "steps/sec". As an effective check, verify the selection by checking the force at the required step rate.

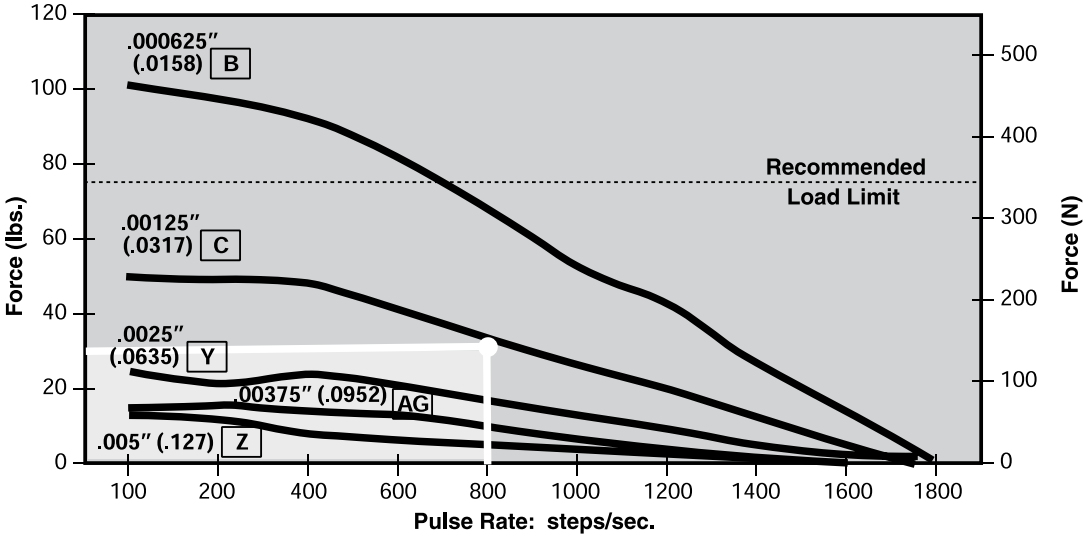
| | |
|---|---|
| Resolution chosen | 0.00125 in / step ("C" screw) |
| Required linear velocity | 1.0 in / sec |
| Required step rate | (1.0 in / sec) / (0.00125 in / step) = 800 steps / sec |

The intercept of the required force and pulse rate (load point) is confirmed to fall under curve "C" as calculated.

*Figure 17.*

***FORCE vs PULSE RATE SIZE 17 DOUBLE STACK SERIES 43000***

*Ø .250 (6.35 mm) lead-screw, Bipolar, Chopper Drive, 100% Duty Cycle*



### Resolution, Accuracy, and Repeatability – What's The Difference??

In any linear motion application, the subject of resolution, accuracy, and repeatability inevitability comes up. These terms have very different meanings, but are in many cases, used interchangeably.

***Resolution***

This is defined as the incremental distance the actuator's output shaft will extend per input pulse.

Resolution is expressed as inches/step. As seen in the curves above, resolutions are available in fractions or subfractions of an inch per step allowing very controlled linear motion.

**Resolution = (screw lead) / (360 deg / step angle)**

*Example:* Screw lead = 0.096-in / rev (inch / revolution)
Step angle = 1.8 deg / step

**Actuator Resolution = (0.096 in / rev) / (360 deg / (1.8 deg / step) = 0.00048 in / step** (use **"J" screw**)

***Accuracy***

The difference between the theoretical distance and the actual distance traveled. Due to manufacturing tolerances in the individual components of the actuator, the actual travel will be slightly different. The tight design tolerances of the Haydon actuators allow this error to be very small, but nevertheless, it exists. See Figure 18.

For a Haydon® hybrid linear actuator utilizing a screw with a 1-in lead, 360° of rotary motion will result in a theoretical 1-in stoke. In general, the tolerance of a Haydon Hybrid linear actuator with a 1-in move will be +/– 0.0005-in.

***Repeatability***

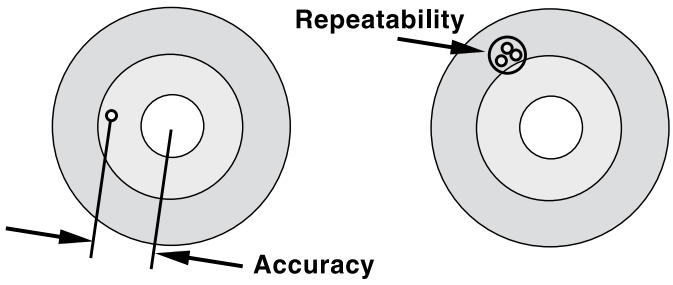
The range of positions attained when the actuator is commanded to approach the same target multiple times under identical conditions.

*Example:*

Allow the actuator to extend a commanded distance from its home position (starting point). Measure and record this distance and call it "x". Retract the actuator back to its home position. Command the actuator to repeatedly return to the commanded distance "x". The differences between the actual distances traveled and "x" is the repeatability.

*Figure 18.*

***ACCURACY and REPEATABILITY***




### Resonance

Stepper motors have a natural resonant frequency as a result of the motor being a spring-mass system. When the step rate equals the motor's natural frequency, there may be an audible change in noise made by the motor, as well as an increase in vibration. The resonant point will vary with the application and load, but typically occurs somewhere between 100 and 250 steps per second. In severe cases the motor may lose steps at the resonant frequency. Changing the step rate is the simplest means of avoiding many problems related to resonance in a system. Also, half stepping or micro stepping usually reduces resonance problems. When accelerating/decelerating to speed, the resonance zone should be passed through as quickly as possible.

## Selecting The Proper Motor Checklist

In order to select the proper motor several factors must be considered. Is linear or rotary motion required? Following is a list of some of the basic requirements to consider when choosing a motor. This will help determine the best choice of an actuator or a rotary motor.

| Rotary Motor | Linear Actuator |
|---|---|
| How much torque is required? | How much force is required? |
| What is the duty cycle? | What is the duty cycle? |
| What is desired step angle? | What is desired step increment? |
| What is the step rate or RPM? | What is the step rate or speed of travel? |
| Bipolar or unipolar coils? | Bipolar or unipolar coils? |
| Coil Voltage? | Coil Voltage? |
| Detent or holding torque requirements? | Must the screw hold position with power off or must it be "backdrivable"with power off? |
| Are there size restrictions? | Are there size restrictions? |
| What is anticipated life requirement? | What is anticipated life requirement? |
| Temperature of operating environment? | Temperature of operating environment? |
| Sleeve or ball bearings? | Captive or non-captive shaft? |
| Radial and axial load? | Type of driver? |
| Type of driver? | |

## Drives

Stepper motors require some external electrical components in order to run. These components typically include a power supply, logic sequencer, switching components and a clock pulse source to determine the step rate. Many commercially available drives have integrated these components into a complete package. Some basic drive units have only the final power stage without the controller electronics to generate the proper step sequencing.

### Bipolar Drive

This is a very popular drive for a two phase bipolar motor having four leads. In a complete driver/controller the electronics alternately reverse the current in each phase. The stepping sequence is shown on page 70.

### Unipolar Drive

This drive requires a motor with a center-tap at each phase (6 leads). Instead of reversing the current in each phase, the drive only has to switch current from one coil to the other in each phase (see page 70). The windings are such that this switching reverses the magnetic fields within the motor. This option makes for a simpler drive but only half of the copper winding is used at any one time. This results in approximately 30% less available torque in a rotary motor or force in a linear actuator as compared to an equivalent bipolar motor.

### L/R Drives

This type of drive is also referred to as a constant voltage drive. Many of these drives can be configured to run bipolar or unipolar stepper motors. L/R stands for the electrical relationship of inductance (L) to resistance (R). Motor coil impedance vs. step rate is determined by these parameters. The L/R drive should "match" the power supply output voltage to the motor coil voltage rating for continuous duty operation. Most published motor performance curves are based on full rated voltage applied at the motor leads. Power supply output voltage level must be set high enough to account for electrical drops within the drive circuitry for optimum continuous operation.

Performance levels of most steppers can be improved by increasing the applied voltage for shortened duty cycles. This is typically referred to as "over-driving" the motor. When over-driving a motor, the operating cycle must have sufficient periodic off time (no power applied) to prevent the motor temperature rise from exceeding the published specification.

### Chopper Drives

A chopper drive allows a stepper motor to maintain greater torque or force at higher speeds than with an L/R drive. The chopper drive is a constant current drive and is almost always the bipolar type. The chopper gets its name from the technique of rapidly turning the output power on and off (chopping) to control motor current. For this setup, low impedance motor coils and the maximum voltage power supply that can be used with the drive will deliver the best performance. As a general rule, to achieve optimum performance, the recommended ratio between power supply and rated motor voltage is eight to one. An eight to one ratio was used for the performance curves in this catalog.

### Microstepping Drives

Many bipolar drives offer a feature called microstepping. Microstepping electronically divides a full step into smaller steps. For instance, if one step of a linear actuator is 0.001 inch, this can be driven to have 10 microsteps per step. In this case, one microstep would normally be 0.0001 inch. Microstepping effectively reduces the step increment of a motor. However, the accuracy of each microstep has a larger percentage of error as compared to the accuracy of a full step. As with full steps, the incremental errors of microsteps are non-cumulative.

### Summary

Stepper motors have been used in a wide array of applications for many years. With trends towards miniaturization, computer control and cost reduction, "hybrid" style stepper motor actuators are being used in an ever increasing range of applications. In particular the use of linear actuators has rapidly expanded in recent years. These precise, reliable motors can be found in many applications including blood analyzers and other medical instrumentation, automated stage lighting, imaging equipment, HVAC equipment, valve control, printing equipment, X-Y tables, integrated chip manufacturing, inspection and test equipment. This attractive technical solution eliminates the use of numerous components and the associated costs related to assembly, purchasing, inventory, etc. The applications for these motors are only limited by the designer's imagination.

## Terminology

**Detent or residual torque:** The torque required to rotate the motor's output shaft with no current applied to the windings.

**Drives:** A term depicting the external electrical components to run a Stepper Motor System. This will include power supplies, logic sequencers, switching components and usually a variable frequency pulse source to determine the step rate.

**Dynamic torque:** The torque generated by the motor at a given step rate. Dynamic torque can be represented by PULL IN torque or PULL OUT torque.

**Holding torque:** The torque required to rotate the motor's output shaft while the windings are energized with a steady state D.C. current.

**Inertia:** The measure of a body's resistance to acceleration or deceleration. Typically used in reference to the inertia of the load to be moved by a motor or the inertia of a motor's rotor.

**Linear step increment:** The linear travel movement generated by the lead-screw with each single step of the rotor.

**Maximum temperature rise:** Allowable increase in motor temperature by design. Motor temperature rise is caused by the internal power dissipation of the motor as a function of load. This power dissipation is the sum total from $I^2R$ (copper loss), iron (core) loss, and friction. The final motor temperature is the sum of the temperature rise and ambient temperature.

**Pulse rate:** The number of pulses per second (pps) applied to the windings of the motor. The pulse rate is equivalent to the motor step rate.

**Pulses per second (PPS):** The number of steps that the motor takes in one second (sometimes called "steps per second"). This is determined by the frequency of pulses produced by the motor drive.

**Ramping:** A drive technique to accelerate a given load from a low step rate, to a given maximum step rate and then to decelerate to the initial step rate without the loss of steps.

**Single step response:** The time required for the motor to make one complete step.

**Step:** The angular rotation produced by the rotor each time the motor receives a pulse. For linear actuators a step translates to a specific linear distance.

**Step angle:** The rotation of the rotor caused by each step, measured in degrees.

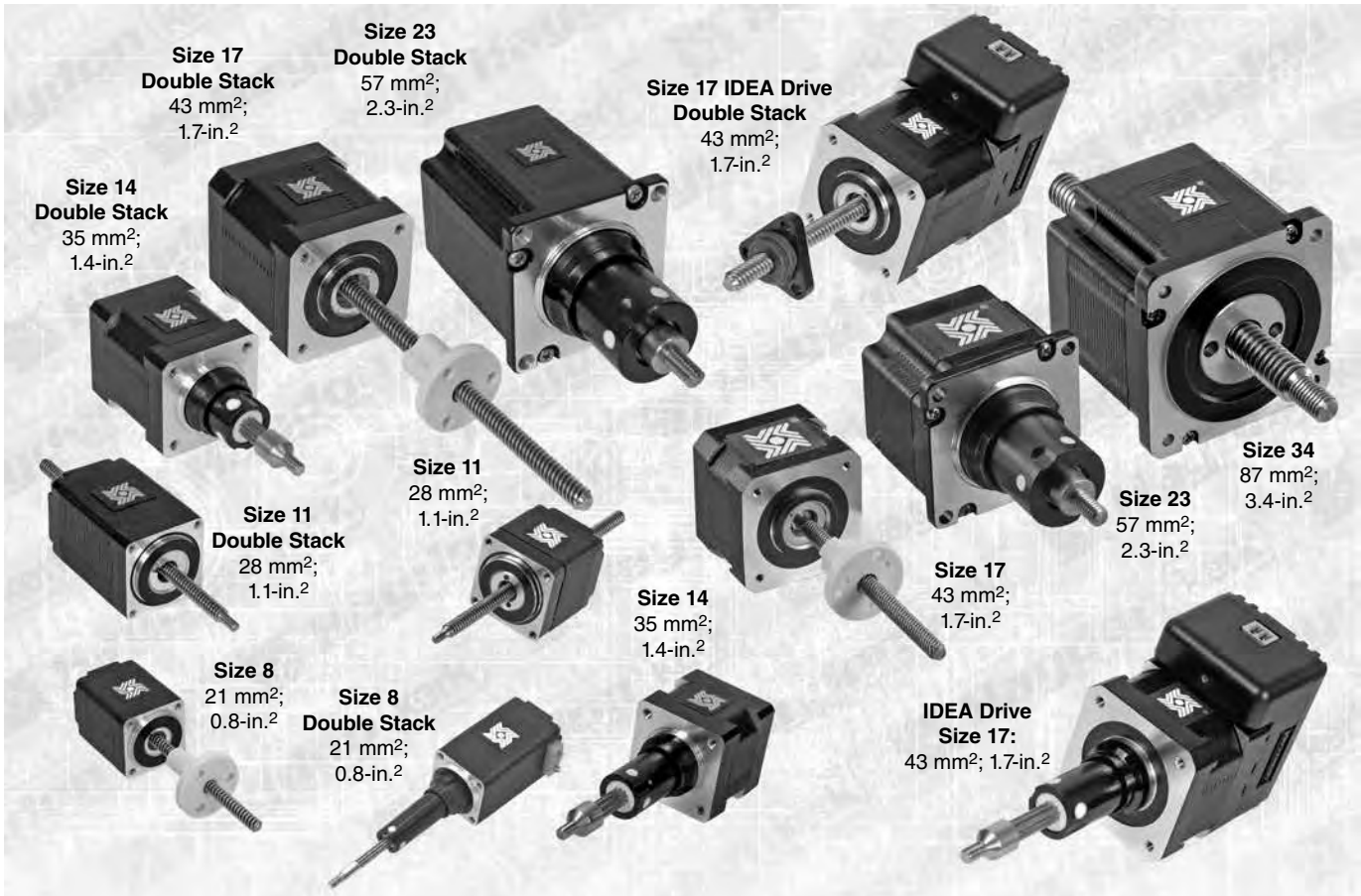
**Steps per revolution:** The total number of steps required for the rotor to rotate 360°.

**Torque:** The sum of the frictional load torque and inertial torque.

- **Pull out torque:** The maximum torque the motor can deliver once the motor isrunning at constant speed. Since there is no change in speed there is no inertial torque. Also, the kinetic energy stored in the rotor and load inertia help to increase the pull out torque.
- **Pull in torque:** The torque required to accelerate the rotor inertia and any rigidly attached external load up to speed plus whatever friction torque must be overcome. Pull in torque, therefore, is always less than pull out torque.

**Torque to inertia ratio:** Holding torque divided by rotor inertia.

# Hybrid Linear Actuators




Haydon Kerk Motion Solutions hybrid linear actuators open new avenues for equipment designers who require high performance and exceptional endurance in a very small package. The various designs use a proprietary manufacturing process, which incorporates engineering thermoplastics in the rotor drive nut and a stainless steel lead-screw. This allows the motor to be much quieter, more efficient and more durable than the v-thread and bronze nut configuration commonly used in other actuators. Motor life is improved more than 10 times over the traditional bronze nut style – and it requires no maintenance and does not affect the cost. An additional feature is the bearing preload adjustment which, unlike other designs, does not protrude from the motor configuration commonly used in other actuators.

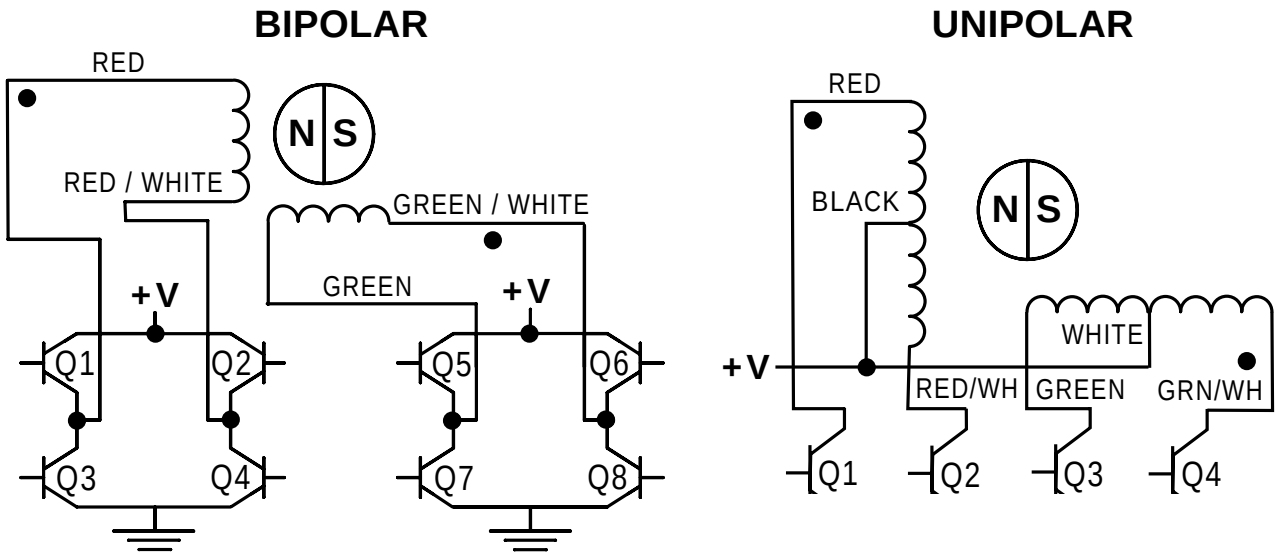
The hybrid actuators come in six sizes, from 21 mm square to 87 mm square. Each size has three designs available – captive, non-captive and an external linear version. Haydon also offers a series of Double Stack enhanced performance hybrid linear actuators available in sizes from 21 mm to 57 mm square. An integrated, programmable IDEA™ Drive is available for the Size 17 (43 mm) hybrid and Double Stack hybrid motors.

There are 28 different travels per step available, from .00006 inch (.001524 mm) to .005 inch (.127 mm). Micro stepping can be used for even finer resolution. Our 87 mm actuator delivers up to 500 pounds (2224 N) of force.

These linear actuators are ideal for applications requiring a combination of precise positioning, rapid motion and long life.

Typical applications include X-Y tables, medical equipment, semiconductor handling, telecommunications equipment, valve control, and numerous other uses. Sold at competitive prices, this product is an excellent value for incorporation into your next project. In addition to standard configurations, Haydon Kerk Motion Solutions can custom design these motors to meet your specific application needs. Lead time for standard prototype designs is usually 2 to 3 days, and 4 to 6 weeks for production orders.

## Hybrid Linear Actuator: Bipolar and Unipolar Wiring




## Hybrid Linear Actuator: Bipolar and Unipolar Stepping Sequence

| Bipolar | Q2-Q3 | Q1-Q4 | Q6-Q7 | Q5-Q8 |
|---|---|---|---|---|
| Unipolar | Q1 | Q2 | Q3 | Q4 |
| Step | | | | |
| 1 | ON | OFF | ON | OFF |
| 2 | OFF | ON | ON | OFF |
| 3 | OFF | ON | OFF | ON |
| 4 | ON | OFF | OFF | ON |
| 1 | ON | OFF | ON | OFF |

EXTEND CW ↓

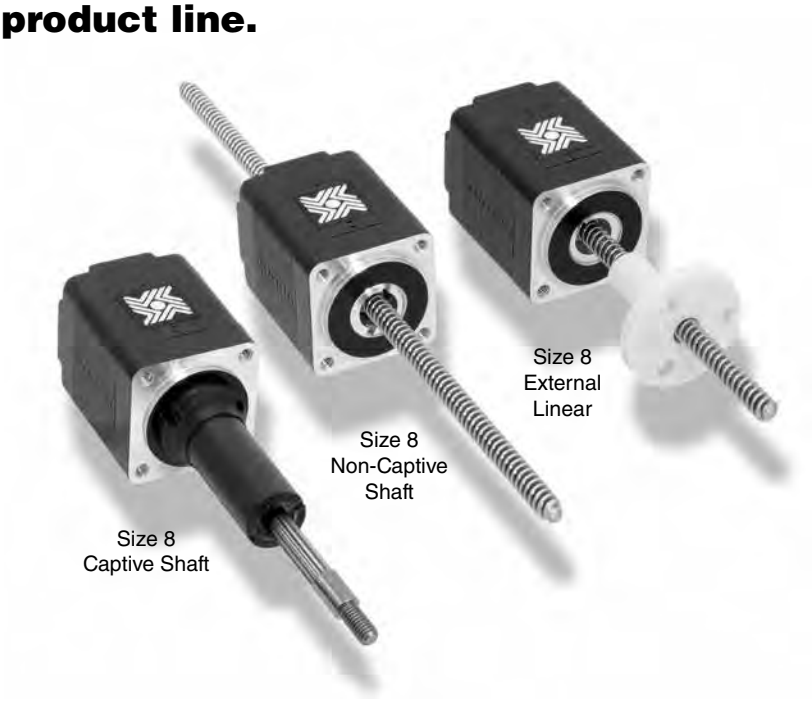
RETRACT CCW ↑

**Note:** Half stepping is accomplished by inserting an off state between transitioning phases.

# One of the world's smallest linear actuators, the Size 8 precision motor is a recent addition to our extensive, award winning miniature stepper motor product line.

Equipment designers and engineers now have an even more compact option for their motion applications. The Haydon® 21000 Series Size 8 linear actuator occupies a minimal 0.8" (21 mm) space and includes numerous patented innovations that provide customers high performance and endurance in a very small package.

Three designs are available, captive, non-captive and external linear versions. The 21000 Series is available in a wide variety of resolutions - from 0.00006" (.0015 mm) per step to 0.00157" (0.04 mm) per step. The Size 8 actuator delivers thrust of up to 10 lbs. (44 N).




## Specifications

| **Size 8: 21 mm (0.8-in) Hybrid Linear Actuator** (1.8° Step Angle) | | | | |
|---|---|---|---|---|
| Part No. | Captive | 21H4 ■–■■–■■■† | | |
| | Non-captive | 21F4 ■–■■–■■■† | | |
| | External Lin. | E21H4 ■–■■–■■■† | | |
| Wiring | | Bipolar | | |
| Winding Voltage | | 2.5 VDC | 5 VDC | 7.5 VDC |
| Current (RMS)/phase | | .49 A | .24 A | .16 A |
| Resistance/phase | | 5.1 Ω | 20.4 Ω | 45.9 Ω |
| Inductance/phase | | 1.5 mH | 5.0 mH | 11.7 mH |
| Power Consumption | | 2.45 W Total | | |
| Rotor Inertia | | 1.4 gcm$^2$ | | |
| Insulation Class | | Class B (Class F available) | | |
| Weight | | 1.5 oz (43 g) | | |
| Insulation Resistance | | 20 MΩ | | |

† Part numbering information on page 72.

| **Linear Travel / Step** Screw Ø.14-in(3.56 mm) inches | mm | **Order Code I.D.** |
|---|---|---|
| .00006 | .0015* | U** |
| .000098* | .0025 | AA** |
| .00012 | .0030* | N |
| .00019* | .005 | AB |
| .00024 | .006* | K |
| .00039* | .01 | AC |
| .00048 | .0121* | J |
| .00078* | .02 | AD |
| .00157* | .04 | AE |

*Values truncated
**TFE coating not available

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

## *Identifying the Hybrid part number codes when ordering*

Haydon Kerk Express℠
*www.HaydonKerkExpress.com*
Standard products available 24-hrs.



| E | 21 | H | 4 | AB | – | 7.5 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix***
(include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor

***Series number designation***

**21 = 21000**

(Series numbers represent approximate width of motor body)

***Style***

**F** = 1.8° Non-captive
**H** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)

***Code ID Resolution Travel/Step***

**U*** = .00006-in (.0015)
**AA*** = .000098-in (.0025)
**N** = .00012-in (.0030)
**AB** = .00019-in (.005)
**K** = .00024-in (.006)
**AC** = .00039-in (.01)
**J** = .00048-in (.0121)
**AD** = .00078-in (.02)
**AE** = .00157-in (.04)

**TFE not available*

***Voltage***

**2.5** = 2.5 VDC
**05** = 5 VDC
**7.5** = 7.5 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 73.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

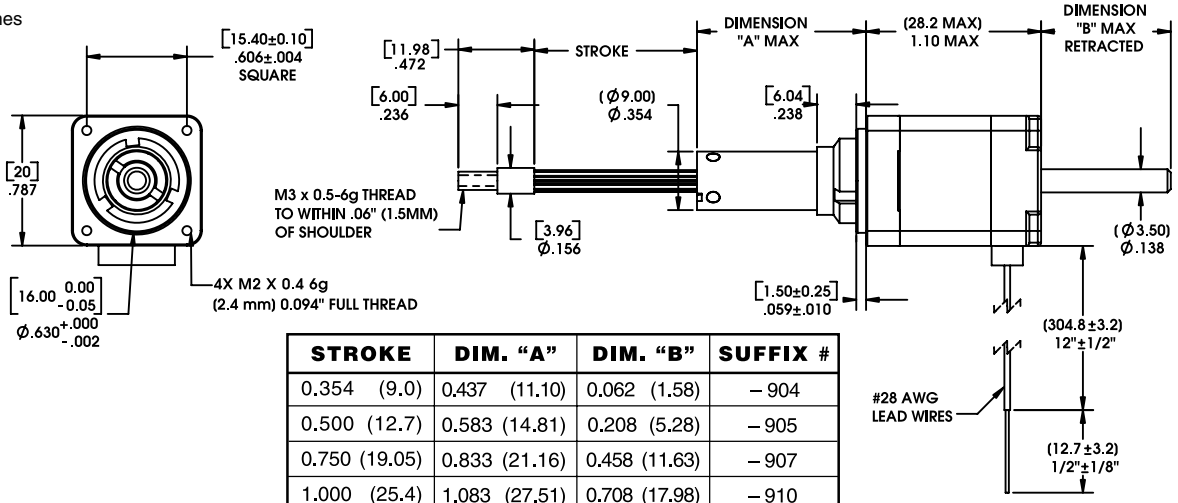
*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

**ENCODERS** and other
**OPTIONAL ASSEMBLIES**
also available

## Captive Lead-screw

Dimensions = (mm) inches

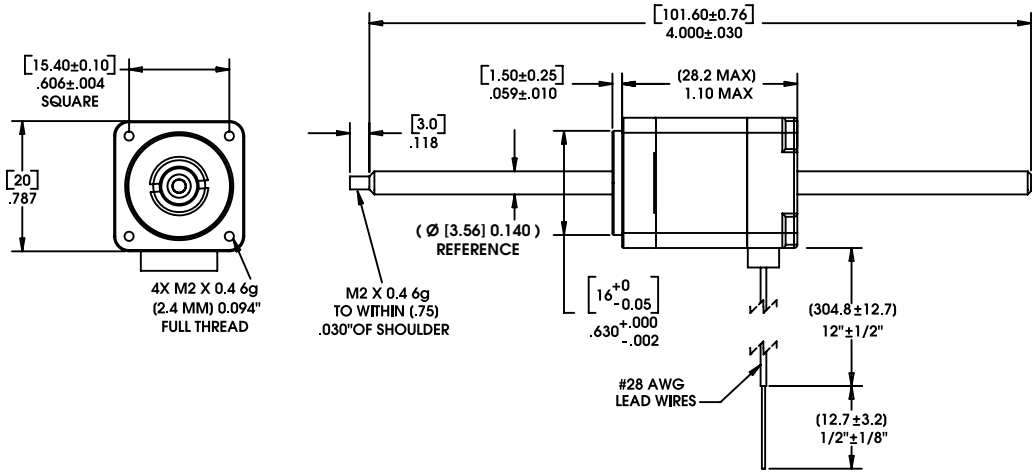



| STROKE | DIM. "A" | DIM. "B" | SUFFIX # |
|---|---|---|---|
| 0.354 (9.0) | 0.437 (11.10) | 0.062 (1.58) | – 904 |
| 0.500 (12.7) | 0.583 (14.81) | 0.208 (5.28) | – 905 |
| 0.750 (19.05) | 0.833 (21.16) | 0.458 (11.63) | – 907 |
| 1.000 (25.4) | 1.083 (27.51) | 0.708 (17.98) | – 910 |
| 1.250 (31.8) | 1.333 (33.86) | 0.958 (24.33) | – 912 |
| 1.500 (38.1) | 1.583 (40.21) | 1.208 (30.68) | – 915 |

## Non-Captive Lead-screw

Dimensions = (mm) inches

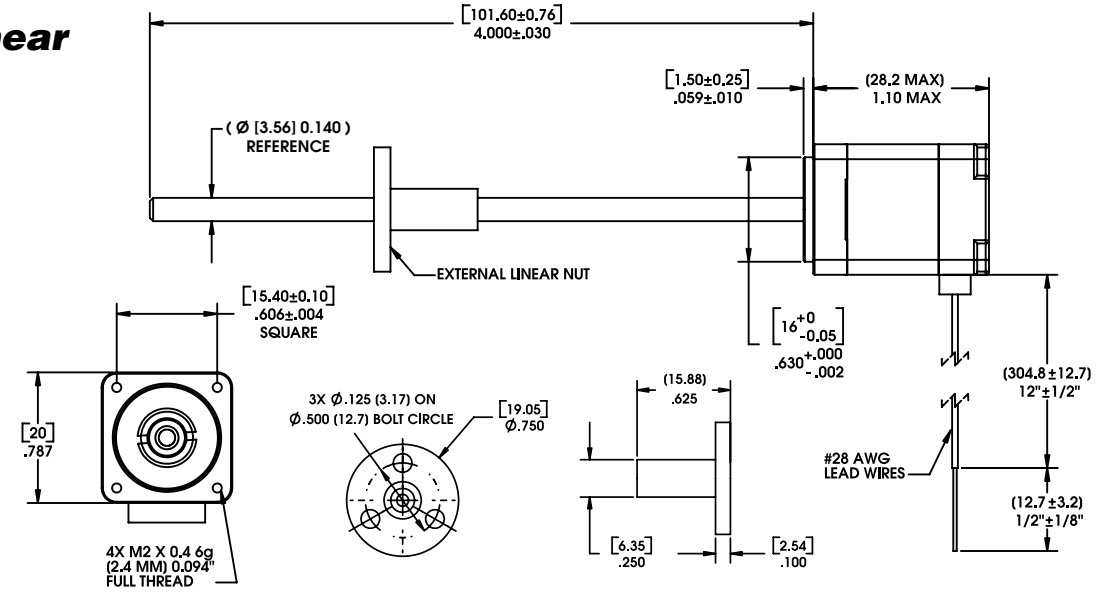
Up to 6-in (152 mm) standard screw lengths. Longer screw lengths are available.




## External Linear

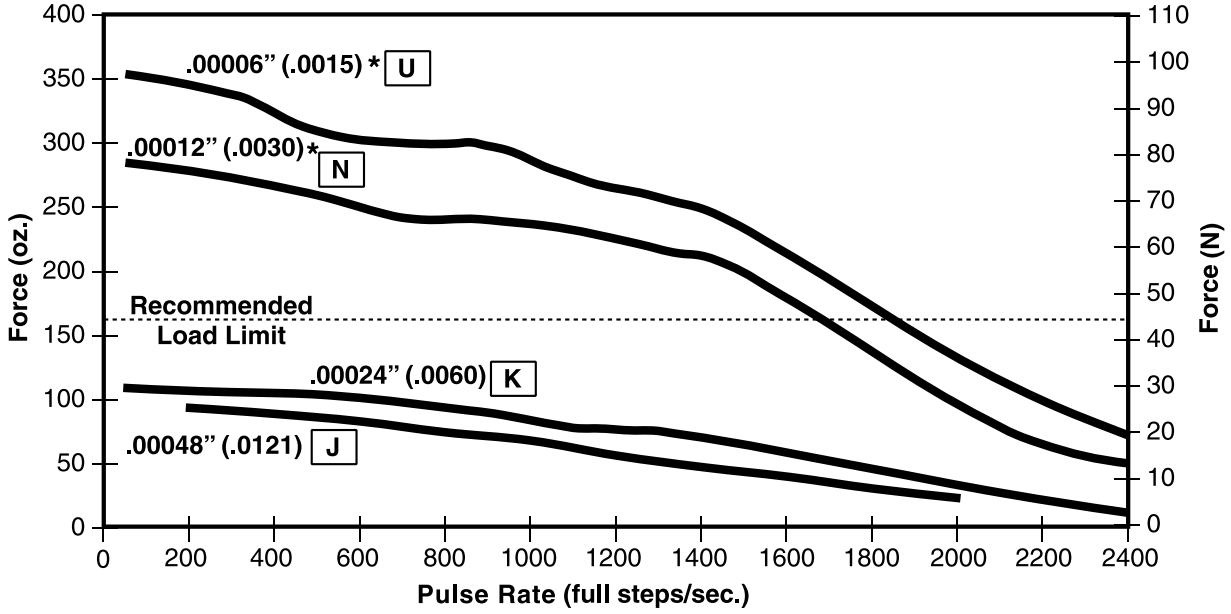
Dimensions = (mm) inches

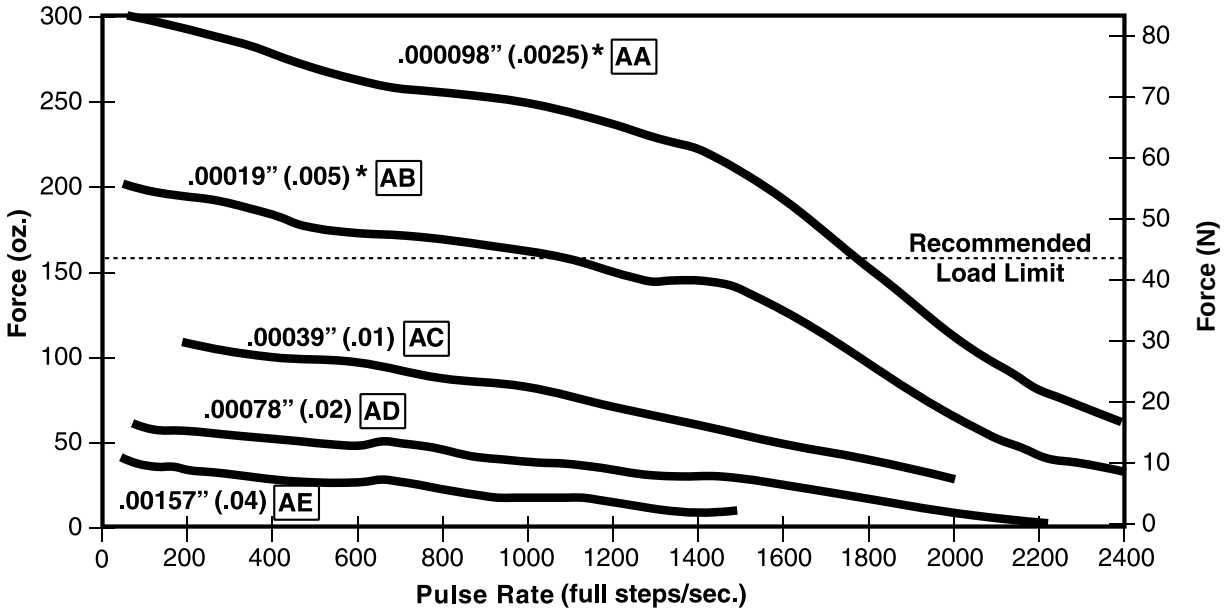
Up to 6-in (152 mm) standard screw lengths. Longer screw lengths are available.



## FORCE vs. PULSE RATE

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .14 (3.56) Lead-screw**




*Care should be taken when utilizing these screw pitches to ensure that the physical load limits of the motor are not exceeded. Please consult the factory for advice in selecting the proper pitch for your application.

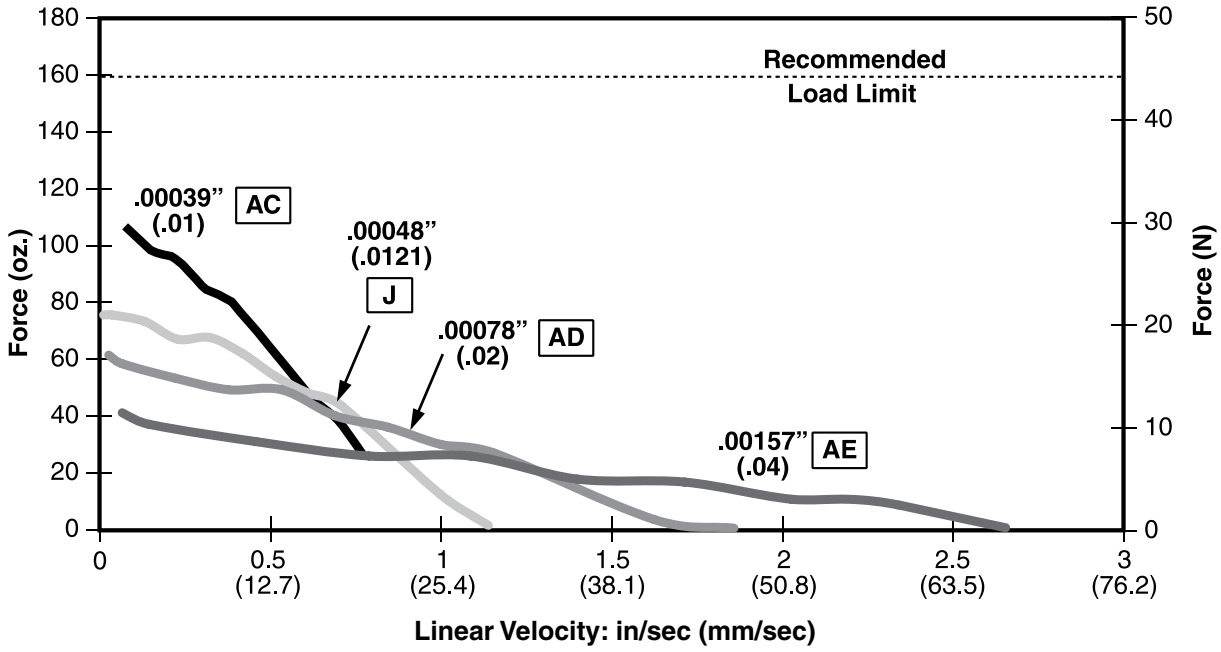
NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

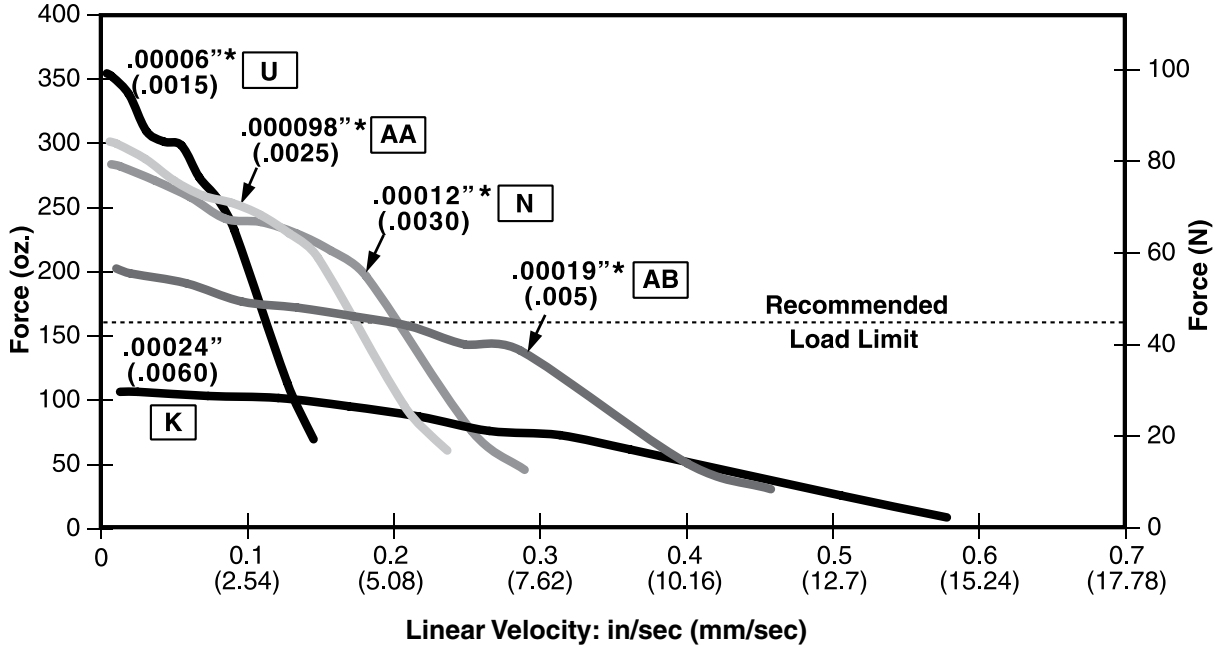
Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## *FORCE vs. LINEAR VELOCITY*

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .14 (3.56) Lead-screw**




*Care should be taken when utilizing these screw pitches to ensure that the physical load limits of the motor are not exceeded. Please consult the factory for advice in selecting the proper pitch for your application.

NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

# Haydon® 21000 Series Size 8 Double Stack hybrid linear actuators provide enhanced performance over a single stack.

**Size 8 Double Stack models deliver improved performance and new linear motion design opportunities in a 20 mm frame size.**

Three designs are available, captive, non-captive and external linear versions. The 21000 Series is available in a wide variety of resolutions - from 0.000098 in (.0025 mm) per step to 0.00157 in (0.04 mm) per step. The Size 8 actuator delivers thrust of up to 17 lbs. (75 N).

**Assembly options include:**
Incremental encoders, proximity sensors (captive types only), anti-backlash and custom nuts, and TFE coated lead-screws.


## Specifications

| Size 8 Double Stack: 21 mm (0.8-in) Hybrid Linear Actuator (1.8° Step Angle) | | | | |
|---|---|---|---|---|
| Part No. | Captive | 21M4 ■–■■–■■■ † | | |
| | Non-captive | 21L4 ■–■■–■■■ † | | |
| | External Lin. | E21M4 ■–■■–■■■ † | | |
| Wiring | | Bipolar | | |
| Winding voltage | | 2.5 VDC | 5 VDC | 7.5 VDC |
| Current (RMS)/phase | | 1.32 A | .65 A | .43 A |
| Resistance/phase | | 1.9 Ω | 7.7 Ω | 17.3 Ω |
| Inductance/phase | | 0.8 mH | 3.2 mH | 6.1 mH |
| Power consumption | | 6.5 W Total | | |
| Rotor inertia | | 2.6 gcm² | | |
| Insulation Class | | Class B (Class F available) | | |
| Weight | | 2.4 oz (68 g) | | |
| Insulation resistance | | 20 MΩ | | |

† Part numbering information on page 77.

| Linear Travel / Step Screw Ø.14-in(3.56 mm) inches | mm | Order Code I.D. |
|---|---|---|
| .000098* | .0025 | AA |
| .00012 | .0030* | N |
| .00019* | .005 | AB |
| .00024 | .006* | K |
| .00039* | 0.01 | AC |
| .00048 | .0121* | J |
| .00078* | .02 | AD |
| .00157* | .04 | AE |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

## Identifying the Hybrid part number codes when ordering

| E | 21 | M | 4 | N | – | 2.5 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix***
(include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor

***Series number designation***

**21 = 21000**

(Series numbers represent approximate width of motor body)

***Style***

**L** = 1.8° Non-captive
**M** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)

***Code ID Resolution Travel/Step***

**AA*** = .000098-in (.0025)
**N** = .00012-in (.0030)
**AB** = .00019-in (.005)
**K** = .00024-in (.006)
**AC** = .00039-in (.01)
**J** = .00048-in (.0121)
**AD** = .00078-in (.02)
**AE** = .00157-in (.04)

**TFE not available*

***Voltage***

**2.5** = 2.5 VDC
**05** = 5 VDC
**7.5** = 7.5 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 78.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

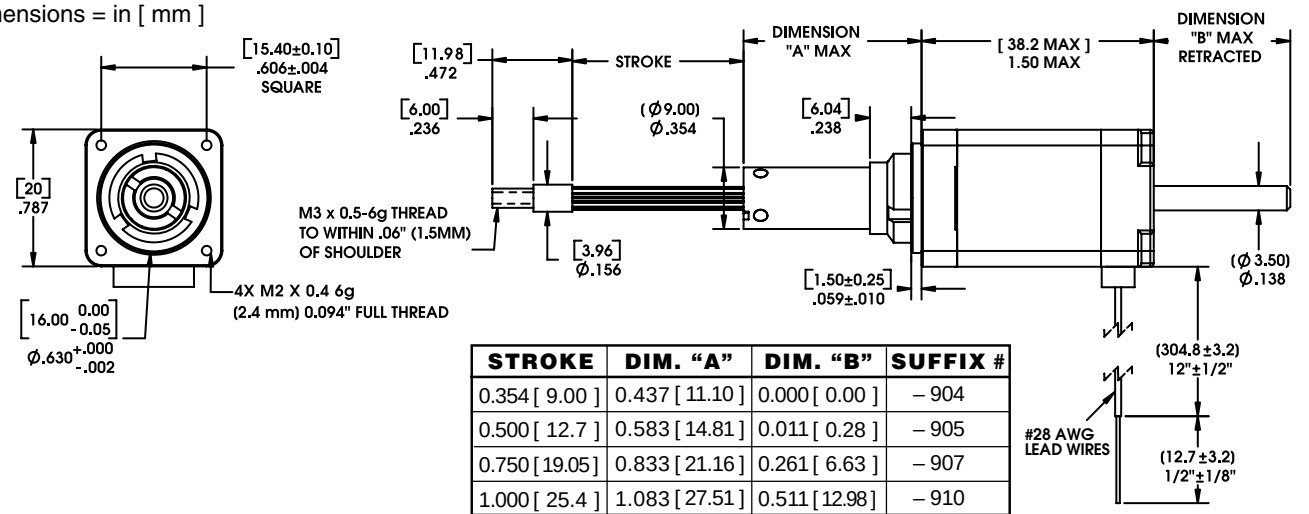
*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

## Captive Lead-screw

Dimensions = in [ mm ]

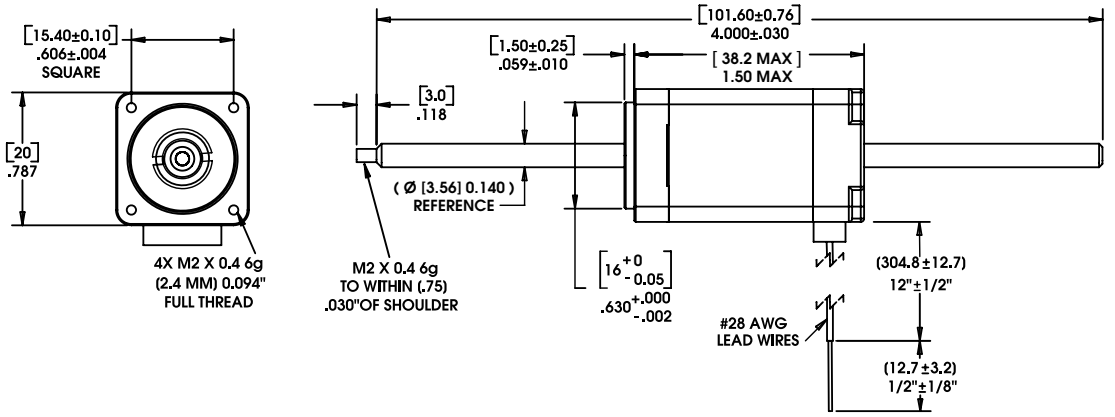



| STROKE | DIM. "A" | DIM. "B" | SUFFIX # |
|---|---|---|---|
| 0.354 [ 9.00 ] | 0.437 [ 11.10 ] | 0.000 [ 0.00 ] | – 904 |
| 0.500 [ 12.7 ] | 0.583 [ 14.81 ] | 0.011 [ 0.28 ] | – 905 |
| 0.750 [ 19.05 ] | 0.833 [ 21.16 ] | 0.261 [ 6.63 ] | – 907 |
| 1.000 [ 25.4 ] | 1.083 [ 27.51 ] | 0.511 [ 12.98 ] | – 910 |
| 1.250 [ 31.8 ] | 1.333 [ 33.86 ] | 0.761 [ 19.33 ] | – 912 |
| 1.500 [ 38.1 ] | 1.583 [ 40.21 ] | 1.011 [ 25.68 ] | – 915 |

## Non-Captive Lead-screw

Dimensions = in [ mm ]

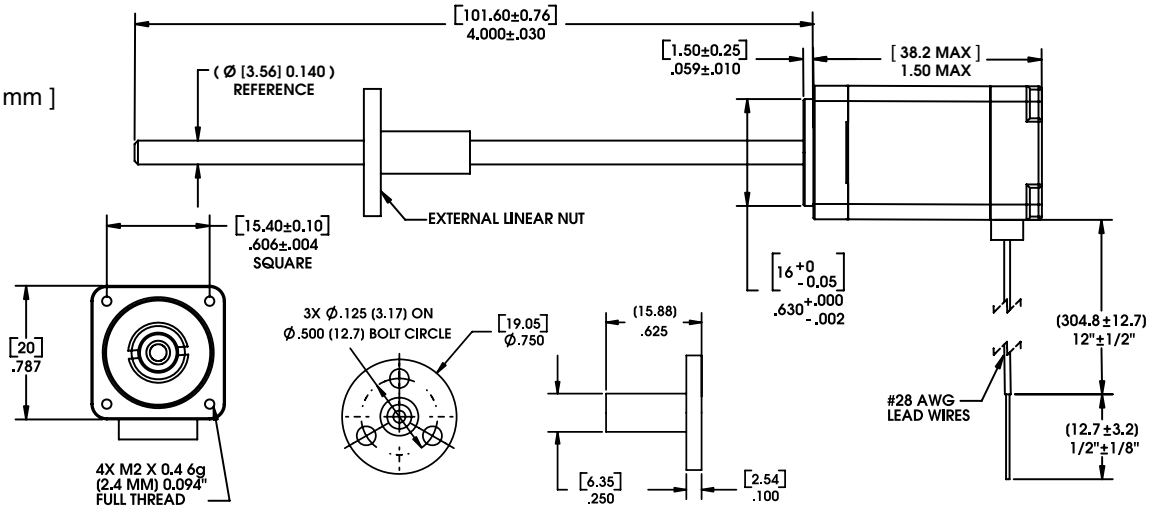
Up to 6 in (152 mm) standard screw lengths. Longer screw lengths are available.




## External Linear

Dimensions = in [ mm ]

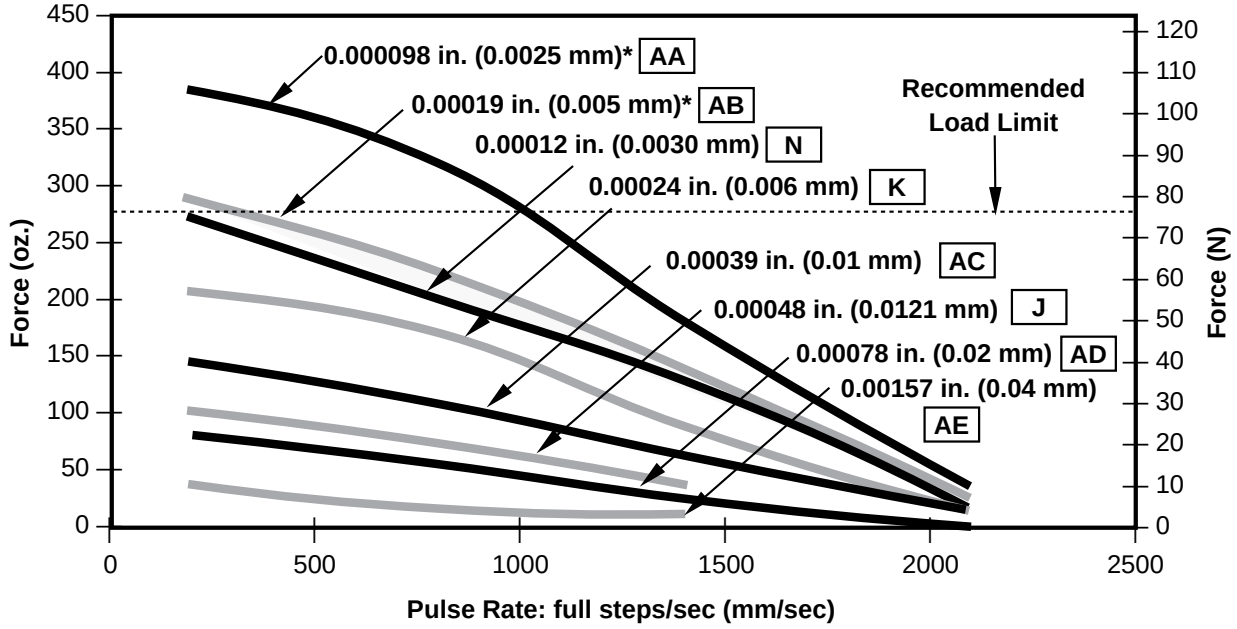
Up to 6 in (152 mm) standard screw lengths. Longer screw lengths are available.



## FORCE vs PULSE RATE

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**

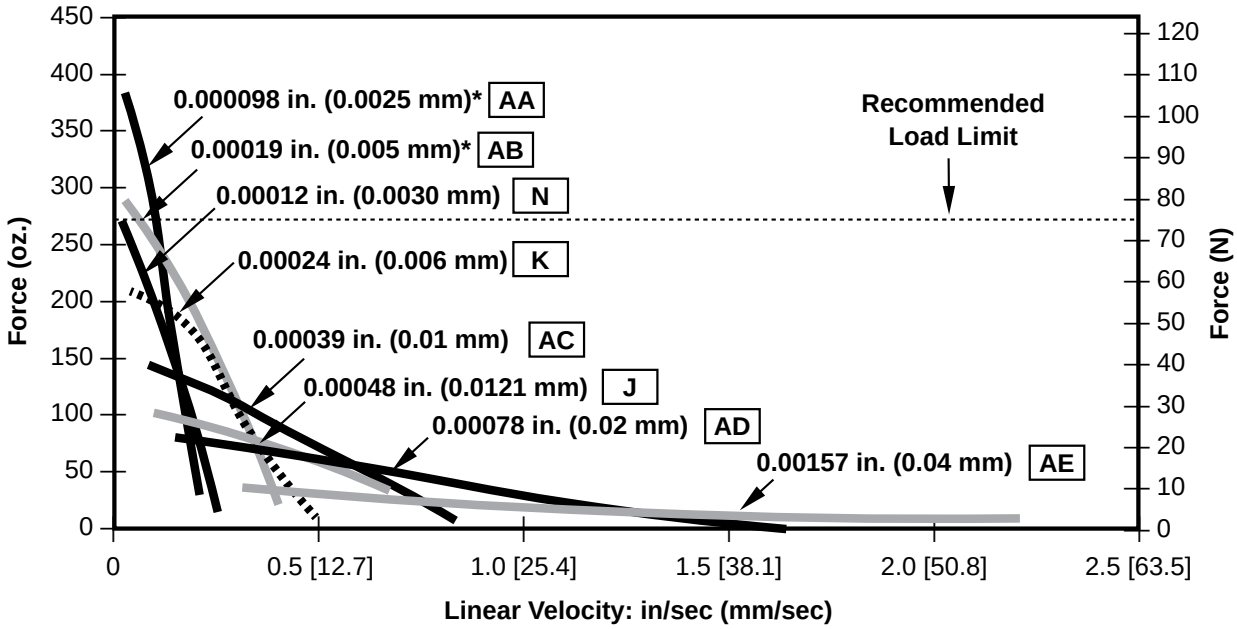
**Ø .14 (3.56) Lead-screw**




## FORCE vs LINEAR VELOCITY

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**

**Ø .14 (3.56) Lead-screw**




*Care should be taken when utilizing these screw pitches to ensure that the physical load limits of the motor are not exceeded. Please consult the factory for advice in selecting the proper pitch for your application.

NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

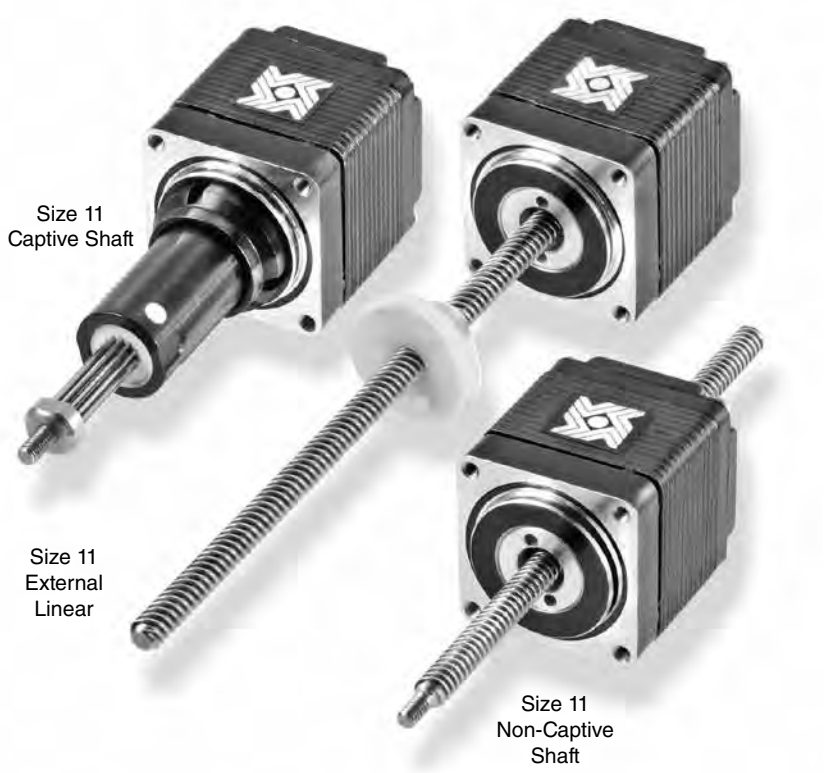
Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

# Haydon® brand Size 11 hybrid linear actuators offer compact, production-proven precision in motion.

The various patented designs deliver high performance, opening avenues for equipment designers who require performance and endurance in a very small package.

Three designs are available, captive, non-captive and external linear versions. The 28000 Series is available in a wide variety of resolutions - from 0.000125-in (.003175 mm) per step to 0.002-in (.0508 mm) per step. The Size 11 actuator delivers thrust of up to 20 lbs. (90 N).




## Specifications

| Size 11: 28 mm (1.1-in) Hybrid Linear Actuator (1.8° Step Angle) | | | | | | |
|---|---|---|---|---|---|---|
| Part No. | Captive | 28H4 ■–■■–■■■† | | | 28H6 ■–■■–■■■† | |
| | Non-captive | 28F4 ■–■■–■■■† | | | 28F6 ■–■■–■■■† | |
| | External Lin. | E28H4 ■–■■–■■■† | | | E28H6 ■–■■–■■■† | |
| Wiring | | Bipolar | | | Unipolar** | |
| Winding Voltage | | 2.1 VDC | 5 VDC | 12 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 1.0 A | 0.42 A | 0.18 A | 0.42 A | 0.18 A |
| Resistance/phase | | 2.1 Ω | 11.9 Ω | 68.6 Ω | 11.9 Ω | 68.6 Ω |
| Inductance/phase | | 1.5 mH | 6.7 mH | 39.0 mH | 3.3 mH | 19.5 mH |
| Power Consumption | | 4.2 W | | | | |
| Rotor Inertia | | 9.0 gcm$^2$ | | | | |
| Insulation Class | | Class B (Class F available) | | | | |
| Weight | | 4.2 oz (119 g) | | | | |
| Insulation Resistance | | 20 MΩ | | | | |

| Linear Travel / Step Screw Ø.1875"(4.76mm) inches | mm | Order Code I.D. |
|---|---|---|
| .000125 | .0031* | 7 |
| .00025 | .0063* | 9 |
| .0005 | .0127 | 3 |
| .001 | .0254 | 1 |
| .002 | .0508 | 2 |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

† Part numbering information on page 81

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

## Identifying the Hybrid part number codes when ordering

Haydon kerk Express℠
www.HaydonKerkExpress.com
Standard products available 24-hrs.

| E | 28 | H | 4 | 7 | – | 05 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix***
(include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**28 = 28000**

(Series numbers represent approximate width of motor body)

***Style***

**F** = 1.8° Non-captive
**H** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)
**6** = Unipolar (6 wire)

***Code ID Resolution Travel/Step***

**1** = .001-in (.0254)
**2** = .002-in (.0508)
**3** = .0005-in (.0127)
**7** = .000125-in (.0031)
**9** = .00025-in (.0063)

***Voltage***

**2.1** = 2.1 VDC (Bipolar only)
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 82.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

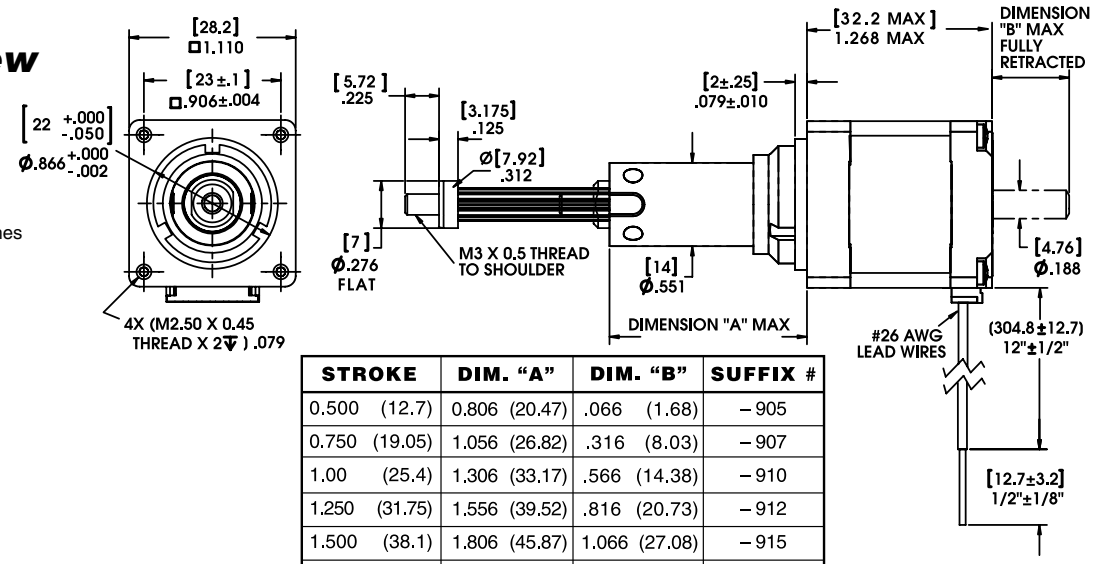
*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

## Captive Lead-screw

Dimensions = (mm) inches



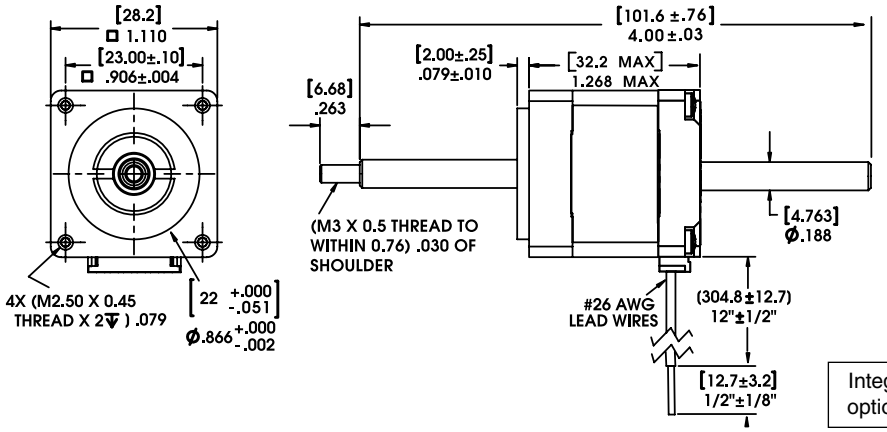

| STROKE | DIM. "A" | DIM. "B" | SUFFIX # |
|---|---|---|---|
| 0.500 (12.7) | 0.806 (20.47) | .066 (1.68) | –905 |
| 0.750 (19.05) | 1.056 (26.82) | .316 (8.03) | –907 |
| 1.00 (25.4) | 1.306 (33.17) | .566 (14.38) | –910 |
| 1.250 (31.75) | 1.556 (39.52) | .816 (20.73) | –912 |
| 1.500 (38.1) | 1.806 (45.87) | 1.066 (27.08) | –915 |
| 2.00 (50.8) | 2.306 (58.57) | 1.566 (39.78) | –920 |
| 2.500 (63.5) | 2.806 (71.27) | 2.066 (52.48) | –925 |

Integrated connector option, see page 117

## Non-Captive Lead-screw

Dimensions = (mm) inches

Up to 8-in (203 mm) standard screw lengths. Longer screw lengths are available.

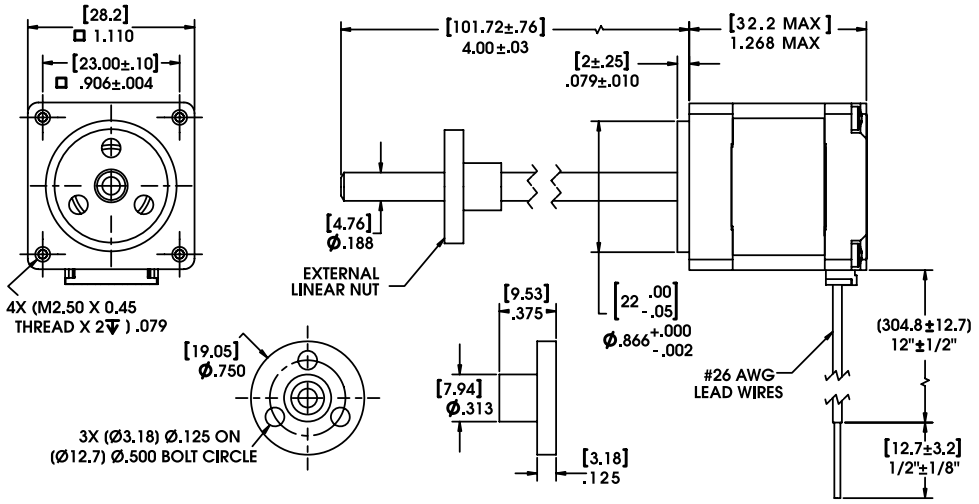



Integrated connector option, see page 117

## External Linear

Dimensions = (mm) inches

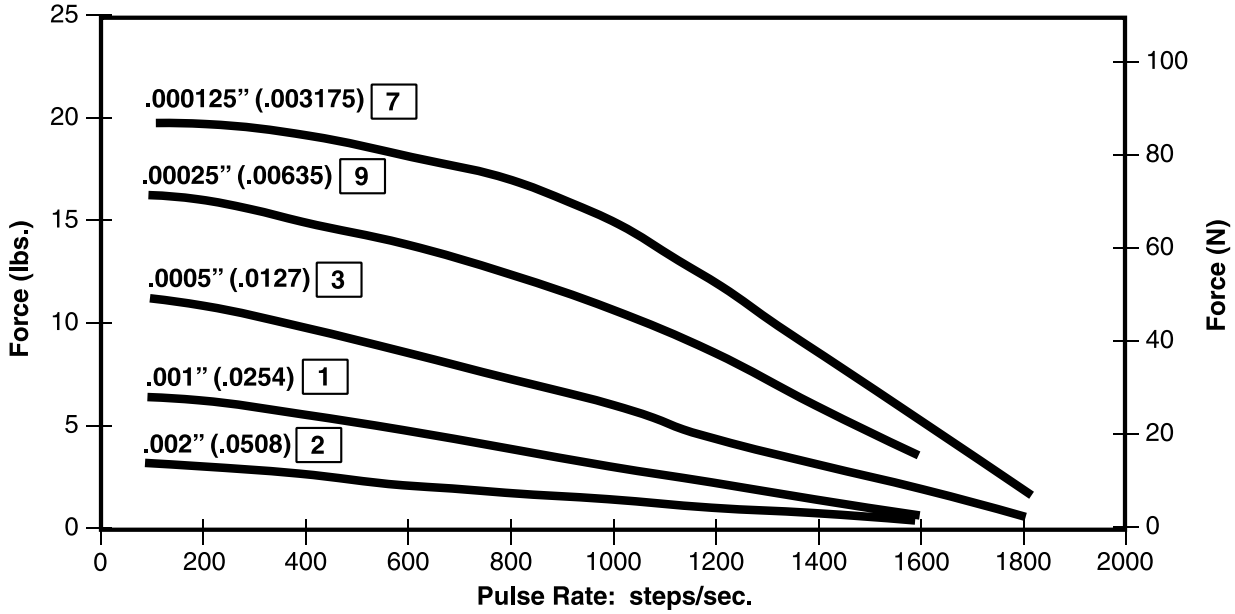
Up to 8-in (203 mm) standard screw lengths. Longer screw lengths are available.




Integrated connector option, see page 117

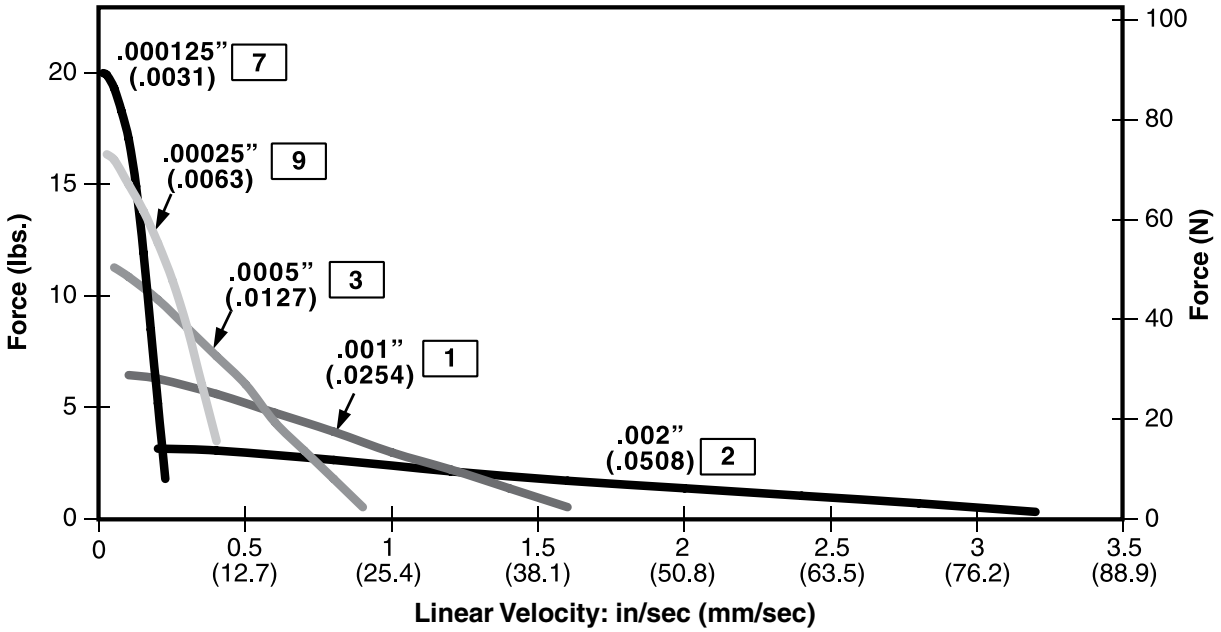
## FORCE vs. PULSE RATE

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .187 (4.75) Lead-screw**




## FORCE vs. LINEAR VELOCITY

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .187 (4.75) Lead-screw**




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

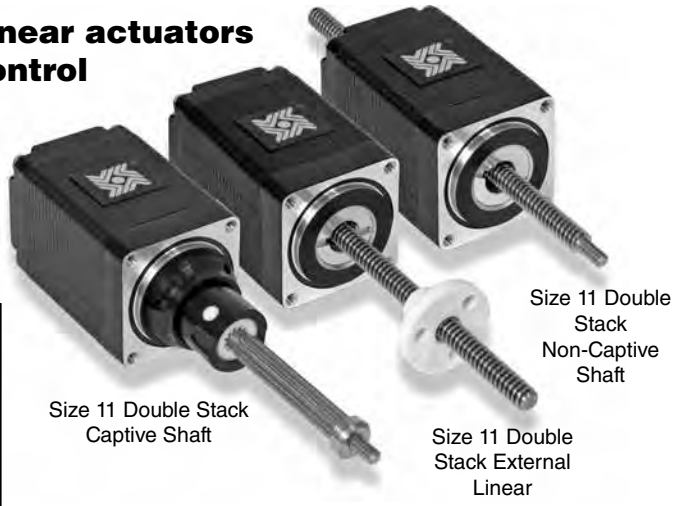
With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

**Haydon Kerk Motion Solutions, Inc.** • www.haydonkerkpittman.com • Phone: 800 243 2715 • International: 203 756 7441



## Haydon® Size 11 Double Stack hybrid linear actuators for enhanced performance in motion control

Three designs are available, captive, non-captive and external linear versions. The 28000 Series is available in a wide variety of resolutions - from 0.000125-in (.003175 mm) per step to 0.002-in (.0508 mm) per step. The Size 11 actuator delivers thrust of up to 30 lbs. (133 N).




## Specifications

| Size 11: 28 mm (1.1-in) Double Stack Hybrid Linear Actuator (1.8° Step Angle) | | | | |
|---|---|---|---|---|
| Part No. | Captive | 28M4 ■ – ■■ – ■■■ † | | |
| | Non-captive | 28L4 ■ – ■■ – ■■■ † | | |
| | External Lin. | E28M4 ■ – ■■ – ■■■ † | | |
| Wiring | | Bipolar | | |
| Winding Voltage | | 2.1 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 1.9 A | 750 mA | 313 mA |
| Resistance/phase | | 1.1 Ω | 6.7 Ω | 34.8 Ω |
| Inductance/phase | | 1.1 mH | 5.8 mH | 35.6 mH |
| Power Consumption | | 7.5 W Total | | |
| Rotor Inertia | | 13.5 gcm² | | |
| Insulation Class | | Class B (Class F available) | | |
| Weight | | 5.8 oz (180 g) | | |
| Insulation Resistance | | 20 MΩ | | |

† Part numbering information below.

| Linear Travel / Step Screw Ø.1875"(4.76mm) inches | mm | Order Code I.D. |
|---|---|---|
| .000125 | .0031* | 7 |
| .00025 | .0063* | 9 |
| .0005 | .0127 | 3 |
| .001 | .0254 | 1 |
| .002 | .0508 | 2 |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

Haydon kerk Express℠
www.HaydonKerkExpress.com
Standard products available 24-hrs.

## *Identifying the Hybrid part number codes when ordering*

**E** – **28** – **M** – **4** – **7** – **05** – **910**

***Prefix*** (include only when using the following)
- **A** = A Coil (See AC Synchronous page 189)
- **E** = External
- **K** = External with 40° thread form
- **P** = Proximity Sensor
- **S** = Home Switch

***Series number designation***

**28 = 28000**

(Series numbers represent approximate width of motor body)

***Style***
- **L** = 1.8° Non-captive
- **M** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***
- **4** = Bipolar (4 wire)

***Code ID Resolution Travel/Step***
- **1** = .001-in (.0254)
- **2** = .002-in (.0508)
- **3** = .0005-in (.0127)
- **7** = .000125-in (.0031)
- **9** = .00025-in (.0063)

***Voltage***
- **2.1** = 2.1 VDC
- **05** = 5 VDC
- **12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 85.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

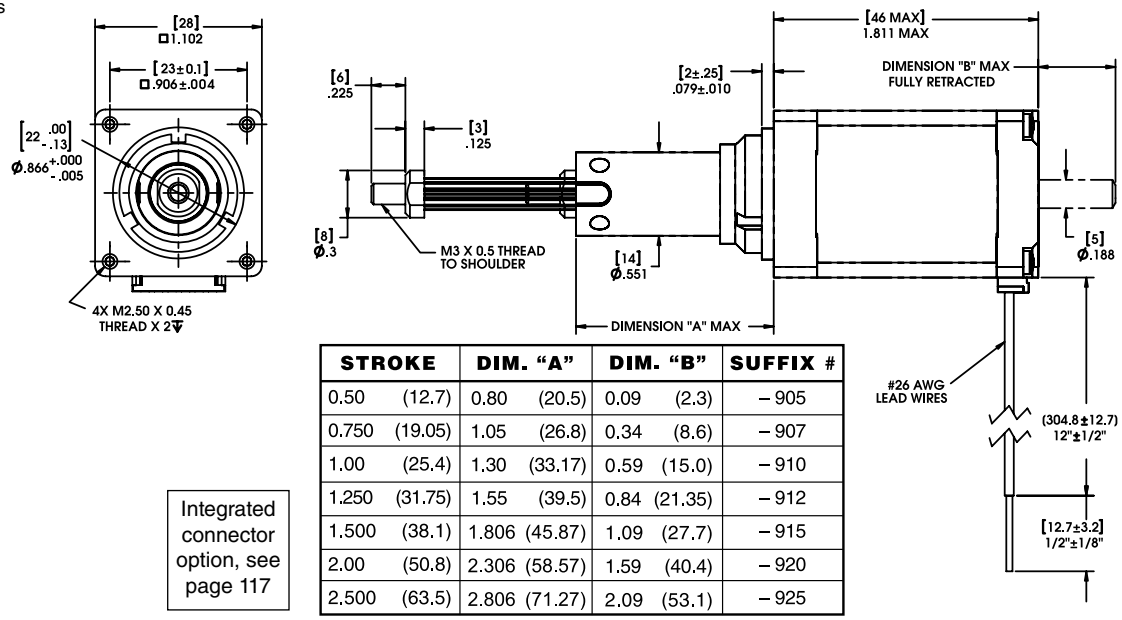
*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

## Captive Lead-screw

Dimensions = (mm) inches



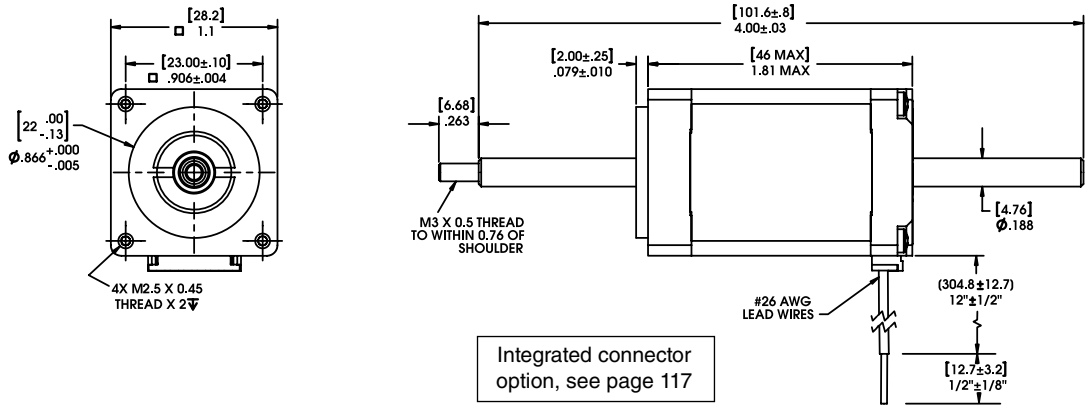

| STROKE | DIM. "A" | DIM. "B" | SUFFIX # |
|---|---|---|---|
| 0.50 (12.7) | 0.80 (20.5) | 0.09 (2.3) | – 905 |
| 0.750 (19.05) | 1.05 (26.8) | 0.34 (8.6) | – 907 |
| 1.00 (25.4) | 1.30 (33.17) | 0.59 (15.0) | – 910 |
| 1.250 (31.75) | 1.55 (39.5) | 0.84 (21.35) | – 912 |
| 1.500 (38.1) | 1.806 (45.87) | 1.09 (27.7) | – 915 |
| 2.00 (50.8) | 2.306 (58.57) | 1.59 (40.4) | – 920 |
| 2.500 (63.5) | 2.806 (71.27) | 2.09 (53.1) | – 925 |

Integrated connector option, see page 117

## Non-Captive Lead-screw

Dimensions = (mm) inches

Up to 6-in (152 mm) standard screw lengths. Longer screw lengths are available.

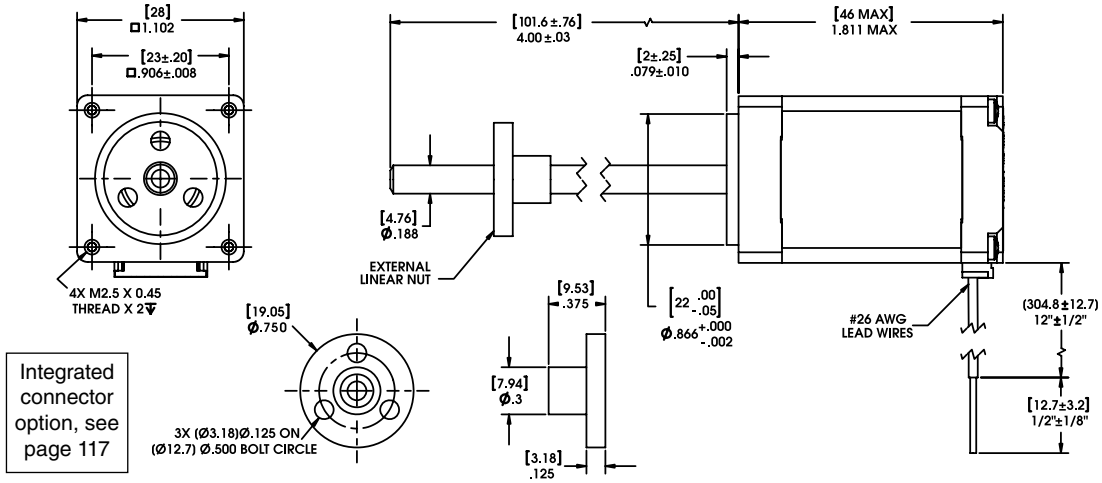



Integrated connector option, see page 117

## External Linear

Dimensions = (mm) inches

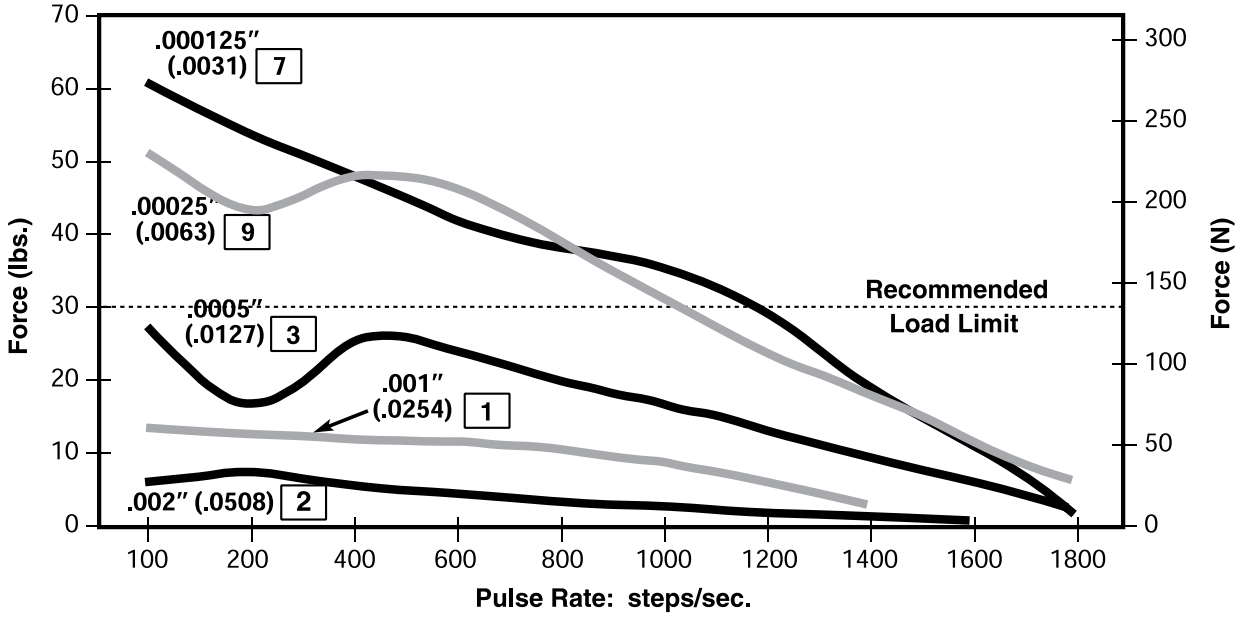
Up to 6-in (152 mm) standard screw lengths. Longer screw lengths are available.




Integrated connector option, see page 117

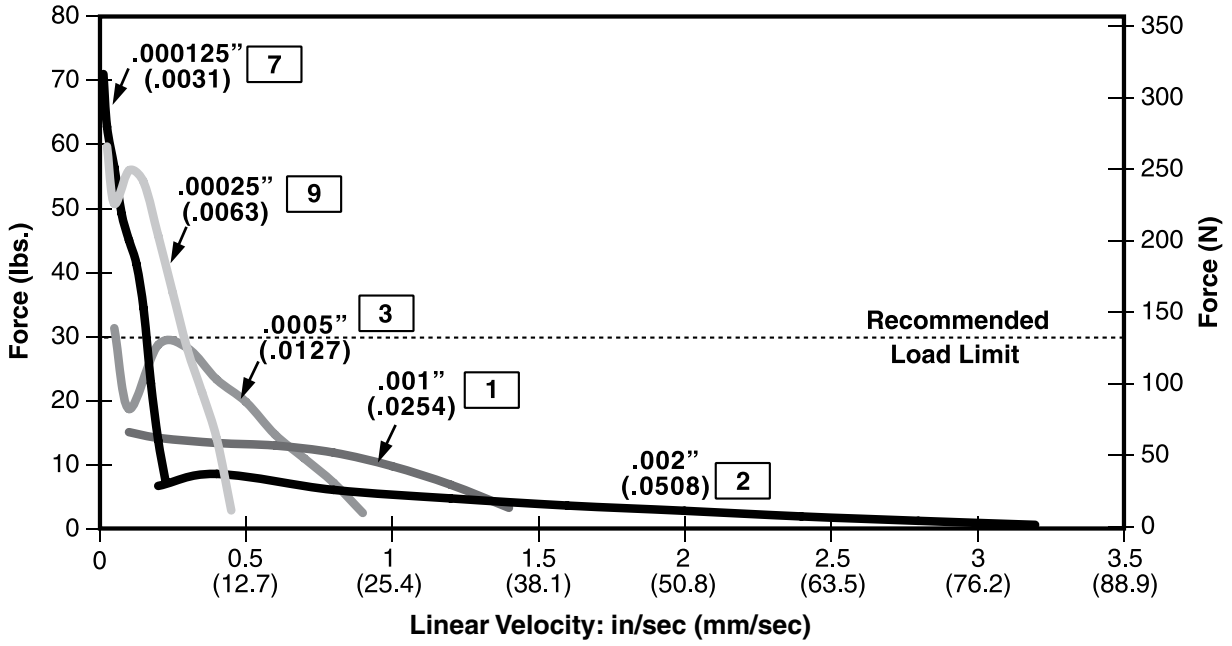
## FORCE vs. PULSE RATE

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .187 (4.75) Lead-screw**




## FORCE vs. LINEAR VELOCITY

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .187 (4.75) Lead-screw**




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## Haydon® 35000 Series Size 14 hybrid linear actuators have been improved to provide higher force, longer life and improved performance.

The various designs deliver exceptional performance and new linear motion design opportunities. Three designs are available, captive, non-captive and external linear versions. The 35000 Series is available in a wide variety of resolutions - from 0.00012-in (.003048 mm) per step to 0.00192-in (.048768 mm) per step. The motors can also be microstepped for even finer resolutions. The Size 14 actuator delivers thrust of up to 50 lbs. (222 N).

Size 14
External Linear

Size 14
Non-Captive Shaft

Size 14
Captive Shaft

## Specifications

| Size 14: 35 mm (1.4-in) Hybrid Linear Actuator (1.8° Step Angle) | | | | | | |
|---|---|---|---|---|---|---|
| Part No. | Captive | 35H4 ■–■■–■■■† | | | 35H6 ■–■■–■■■† | |
| | Non-captive | 35F4 ■–■■–■■■† | | | 35F6 ■–■■–■■■† | |
| | External Lin. | E35H4 ■–■■–■■■† | | | E35H6 ■–■■–■■■† | |
| Wiring | | Bipolar | | | Unipolar** | |
| Winding Voltage | | 2.33 VDC | 5 VDC | 12 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 1.25 A | 0.57 A | 0.24 A | 0.57 A | 0.24 A |
| Resistance/phase | | 1.86 Ω | 8.8 Ω | 50.5 Ω | 8.8 Ω | 50.5 Ω |
| Inductance/phase | | 2.8 mH | 13 mH | 60 mH | 6.5 mH | 30 mH |
| Power Consumption | | 5.7 W | | | | |
| Rotor Inertia | | 16.0 gcm$^2$ | | | | |
| Insulation Class | | Class B (Class F available) | | | | |
| Weight | | 5.7 oz (162 g) | | | | |
| Insulation Resistance | | 20 MΩ | | | | |

† Part numbering information on page 88.

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

| Linear Travel / Step | | | | | |
|---|---|---|---|---|---|
| Screw Ø .218" (5.54 mm) inches | mm | Order Code I.D. | Screw Ø .250" (6.35 mm) inches | mm | Order Code I.D. |
| .00012 | .0030* | N | .00015625 | .0039* | P |
| .00024 | .0060* | K | .0003125 | .0079* | A |
| .00048 | .0121* | J | .000625 | .0158* | B |
| .00096 | .0243* | Q | .00125 | .0317* | C |
| .00192 | .0487* | R | | | |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

# 35000 Series: Hybrid Size 14 Single Stack Part Number Identification

**Haydon Kerk Motion Solutions, Inc.** • www.haydonkerkpittman.com • Phone: 800 243 2715 • International: 203 756 7441



## Identifying the Hybrid part number codes when ordering

| E | 35 | H | 4 | N | – | 2.33 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix***
(include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**35 = 35000**

(Series numbers represent approximate width of motor body)

***Style***

**F** = 1.8° Non-captive
**H** = 1.8° Captive or External (use "E" or "K" Prefix for External version)
**J** = 0.9° Non-captive
**K** = 0.9° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)
**6** = Unipolar (6 wire)

***Code ID Resolution Travel/Step***

**N** = .00012-in (.0030)
**K** = .00024-in (.0060)
**J** = .00048-in (.0121)
**Q** = .00096-in (.0243)
**P** = .00015625-in (.0039)
**A** = .0003125-in (.0079)
**B** = .000625-in (.0158)
**C** = .00125-in (.0317)
**R** = .00192-in (.0478)

**High Resolution**

**U** = .00006-in (.0015)
**V** = .000078-in (.00198)

***Voltage***

**2.33** = 2.33 VDC
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 89.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

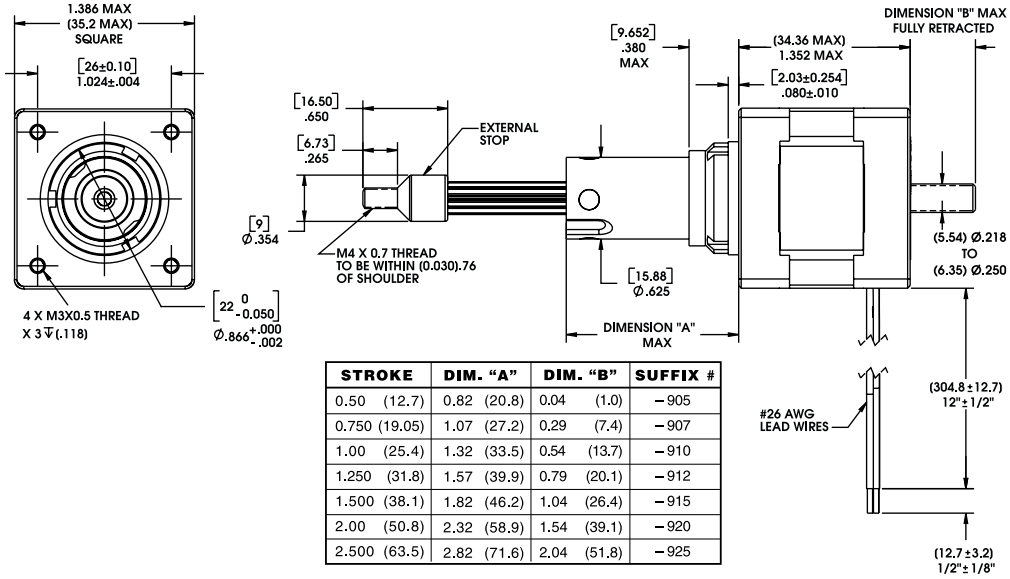
*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

## Captive Lead-screw

Dimensions = (mm) inches



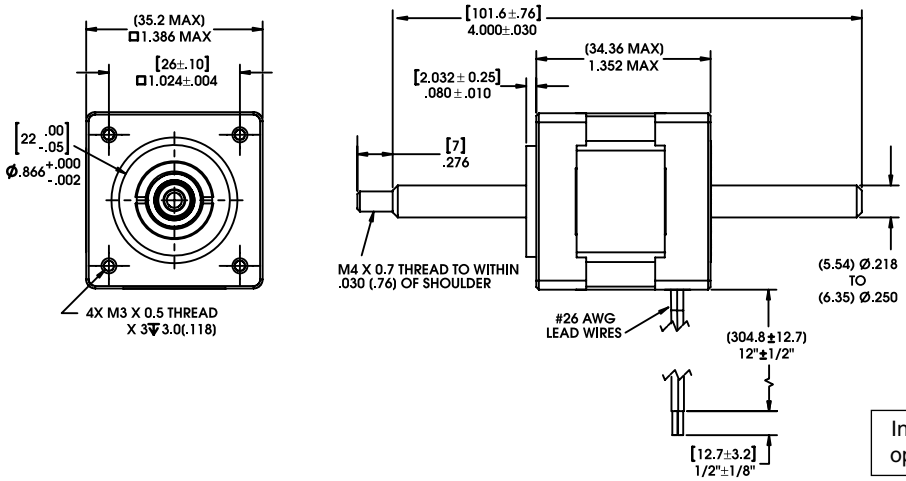

| STROKE | DIM. "A" | DIM. "B" | SUFFIX # |
|---|---|---|---|
| 0.50 (12.7) | 0.82 (20.8) | 0.04 (1.0) | –905 |
| 0.750 (19.05) | 1.07 (27.2) | 0.29 (7.4) | –907 |
| 1.00 (25.4) | 1.32 (33.5) | 0.54 (13.7) | –910 |
| 1.250 (31.8) | 1.57 (39.9) | 0.79 (20.1) | –912 |
| 1.500 (38.1) | 1.82 (46.2) | 1.04 (26.4) | –915 |
| 2.00 (50.8) | 2.32 (58.9) | 1.54 (39.1) | –920 |
| 2.500 (63.5) | 2.82 (71.6) | 2.04 (51.8) | –925 |

Integrated connector option, see page 117

## Non-Captive Lead-screw

Dimensions = (mm) inches

Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.

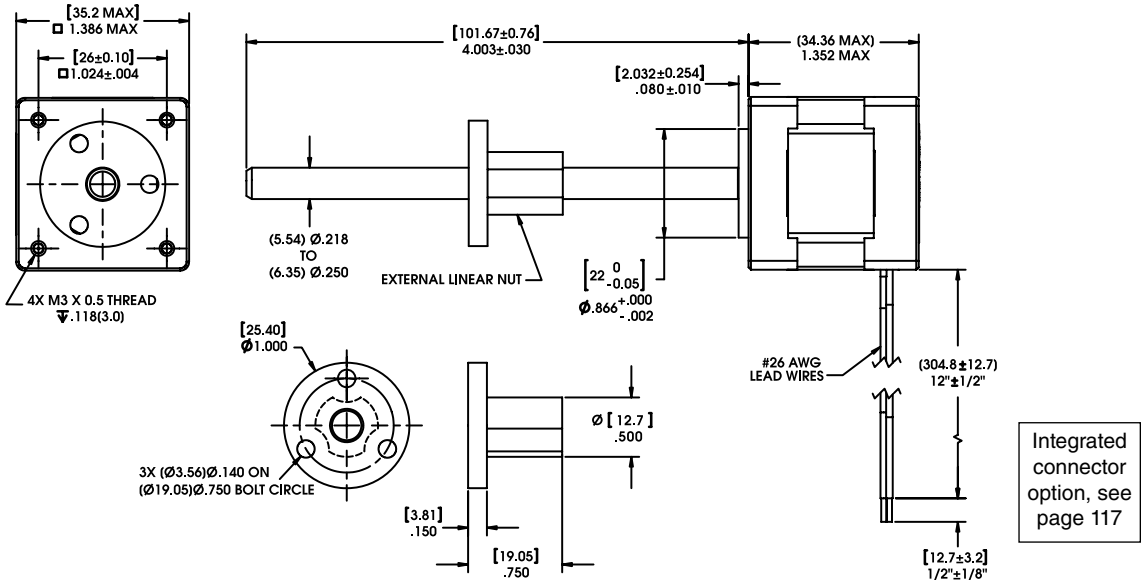



Integrated connector option, see page 117

## External Linear

Dimensions = (mm) inches

Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.

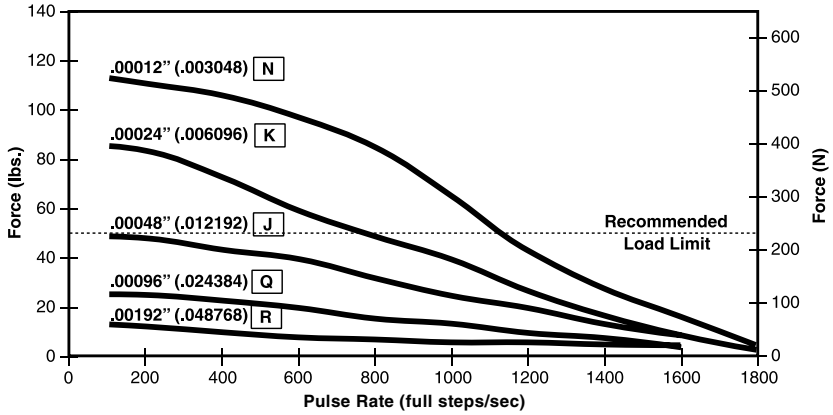



Integrated connector option, see page 117

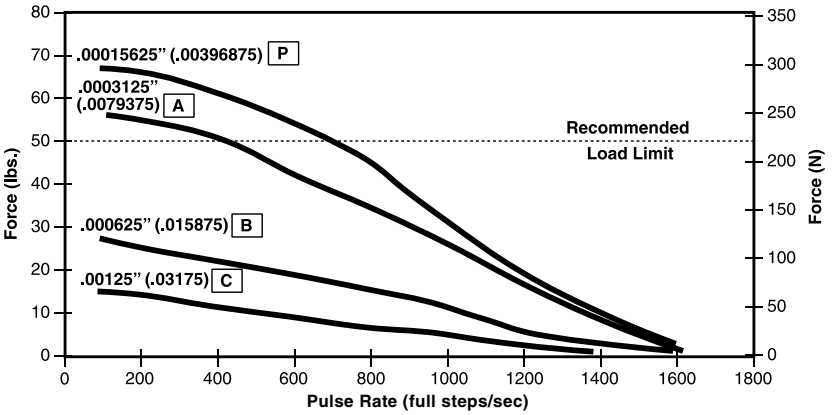
## FORCE vs. PULSE RATE

- Chopper
- Bipolar
- 100% Duty Cycle
- 8:1 Motor Coil to Drive Supply Voltage

**Ø .218 (5.54) Lead-screw >**



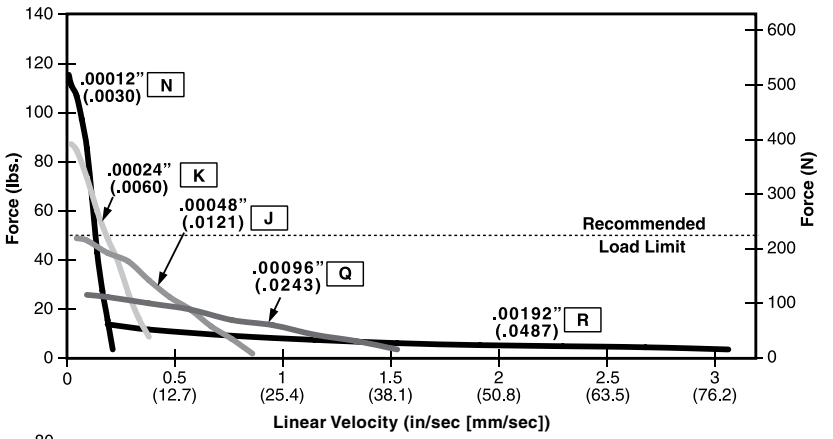

**Ø .250 (6.35) Lead-screw >**



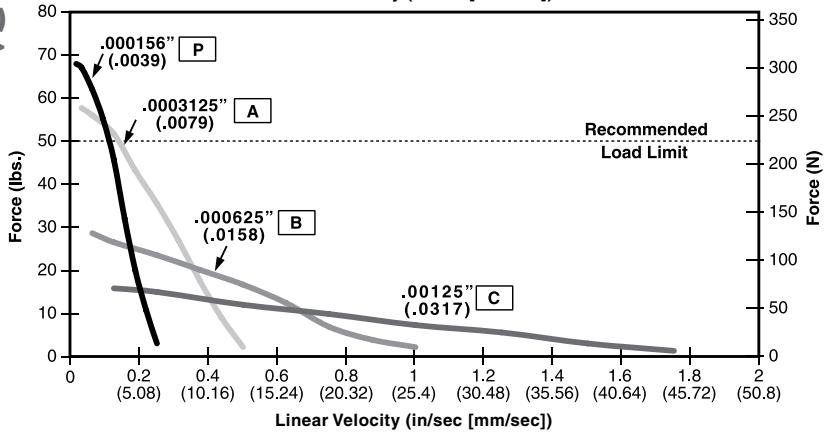

## FORCE vs. LINEAR VELOCITY

- Chopper
- Bipolar
- 100% Duty Cycle
- 8:1 Motor Coil to Drive Supply Voltage

**Ø .218 (5.54) Lead-screw >**




**Ø .250 (6.35) Lead-screw >**




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## The Haydon® 35000 Series Size 14, 0.9° high resolution motor

Compared to the standard resolution (1.8°) this motor has been engineered to precisely deliver reliable high speed, force, up to 50 lbs (222 N), as well as a full step movement as low as 1.5 microns.

## Specifications

| **Size 14: 35 mm (1.4-in) Hybrid Linear Actuator** (0.9° Step Angle) | | | | | | |
|---|---|---|---|---|---|---|
| Part No. | Captive | 35K4 ■-■■-■■■† | | | 35K6 ■-■■-■■■† | |
| | Non-captive | 35J4 ■-■■-■■■† | | | 35J6 ■-■■-■■■† | |
| | External Lin. | E35K4 ■-■■-■■■† | | | E35K6 ■-■■-■■■† | |
| Wiring | | Bipolar | | | Unipolar** | |
| Winding Voltage | | 2.33 VDC | 5 VDC | 12 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 1.25 A | 0.57 A | 0.24 A | 0.57 A | 0.24 A |
| Resistance/phase | | 1.86 Ω | 8.8 Ω | 50.5 Ω | 8.8 | 50.5 Ω |
| Inductance/phase | | 2.8 mH | 13 mH | 60 mH | 6.5 mH | 30 mH |
| Power Consumption | | 5.7 W | | | | |
| Rotor Inertia | | 16 gcm² | | | | |
| Insulation Class | | Class B (Class F available) | | | | |
| Weight | | 5.7 oz (162 g) | | | | |
| Insulation Resistance | | 20 MΩ | | | | |

| **Linear Travel / Step** | | | | | |
|---|---|---|---|---|---|
| Screw Ø .218" (5.54 mm) inches | mm | **Order Code I.D.** | Screw Ø .250" (6.35 mm) inches | mm | **Order Code I.D.** |
| .00006 | .0015* | U | .000078* | .00198* | V |
| .00012 | .0030* | N | .00015625 | .0039* | P |
| .00024 | .0060* | K | .0003125 | .0079* | A |
| .00048 | .0121* | J | .000625 | .0158* | B |
| .00096 | .0243* | Q | | | |

*Values truncated

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

NOTE: Refer to performance curves on page 100 for codes N, K, J, Q, P, A, B

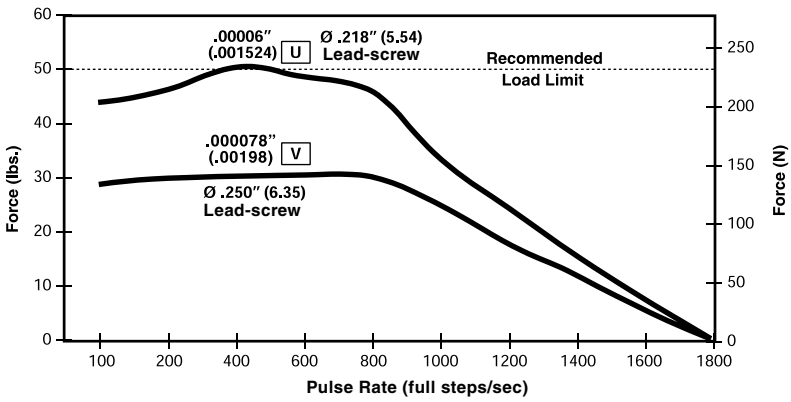
† Part numbering information on page 88.

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

### *FORCE vs. PULSE RATE*

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

– with two available lead-screw diameters

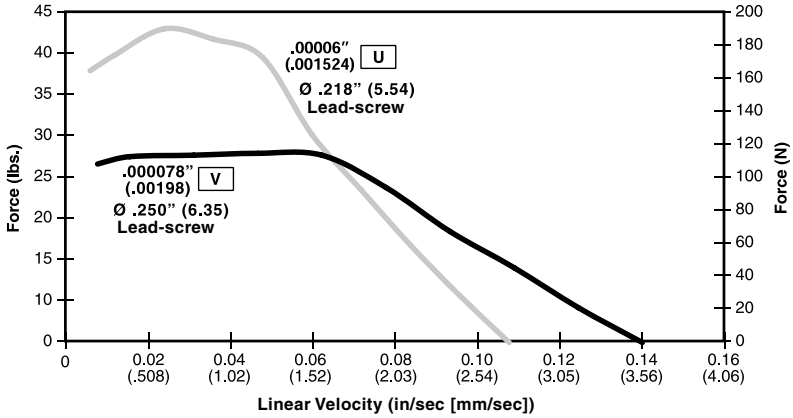



NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

### *FORCE vs. LINEAR VELOCITY*

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

– with two available lead-screw diameters



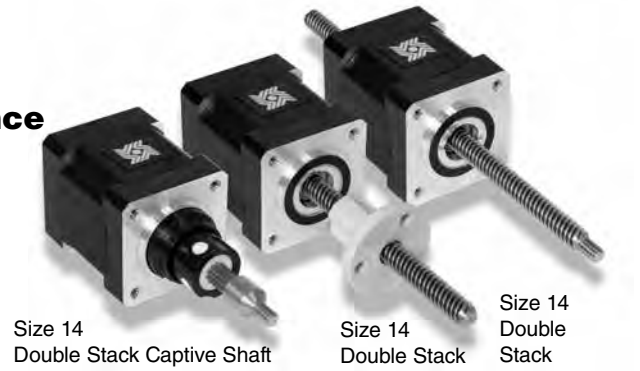

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## 35000 Series Size 14 Double Stack linear actuators for improved force and performance

The Size 14 Double Stack designs deliver exceptional performance and new linear motion design opportunities.

Three designs are available, captive, non-captive and external linear versions. The 35000 Series is available in a wide variety of resolutions - from 0.000625-in (.0158 mm) per step to 0.005-in (.127 mm) per step. The motors can also be microstepped for even finer resolutions. The Size 14 actuator delivers thrust of up to 50 lbs. (222 N).



Size 14 Double Stack Captive Shaft

Size 14 Double Stack External Linear

Size 14 Double Stack Non-Captive Shaft

## Specifications

| Size 14: 35 mm (1.4-in) Double Stack Hybrid Linear Actuator (1.8° Step Angle) | | | | |
|---|---|---|---|---|
| Part No. | Captive | 35M4 ■ – ■■ – ■■■ | | |
| | Non-captive | 35L4 ■ – ■■ – ■■■ | | |
| | External Lin. | E35M4 ■ – ■■ – ■■■ | | |
| Wiring | | Bipolar | | |
| Winding Voltage | | 2.33 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 2 A | 910 mA | 380 mA |
| Resistance/phase | | 1.2 Ω | 5.5 Ω | 31.6 Ω |
| Inductance/phase | | 1.95 mH | 7.63 mH | 65.1 mH |
| Power Consumption | | 9.1 W Total | | |
| Rotor Inertia | | 30 gcm$^2$ | | |
| Insulation Class | | Class B (Class F available) | | |
| Weight | | 8.5 oz (240 g) | | |
| Insulation Resistance | | 20 MΩ | | |

| Linear Travel / Step Screw Ø.250" (6.35 mm) inches | mm | Order Code I.D. |
|---|---|---|
| .000625 | .0158* | B |
| .00125 | .0317* | C |
| .0025 | .0635 | Y |
| .00375 | .0953 | AG |
| .005 | .127 | Z |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

Haydon kerk Express℠
www.HaydonKerkExpress.com
Standard products available 24-hrs.

## *Identifying the Hybrid part number codes when ordering*

| E | 35 | L | 4 | B | – | 12 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix*** (include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**35 = 35000**

(Series numbers represent approximate width of motor body)

***Style***

**L** = 1.8° Non-captive
**M** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)

***Code ID Resolution Travel/Step***

**B** = .000625-in (.0158)
**C** = .00125-in (.0317)
**Y** = .0025-in (.0635)
**AG** = .00375-in (.0953)
**Z** = .005-in (.127)

***Voltage***

**2.33** = 2.33 VDC
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 93.)*

***Suffix also represents:***

*– 800 = Metric*

*– 900 = External Linear with grease and flanged nut*

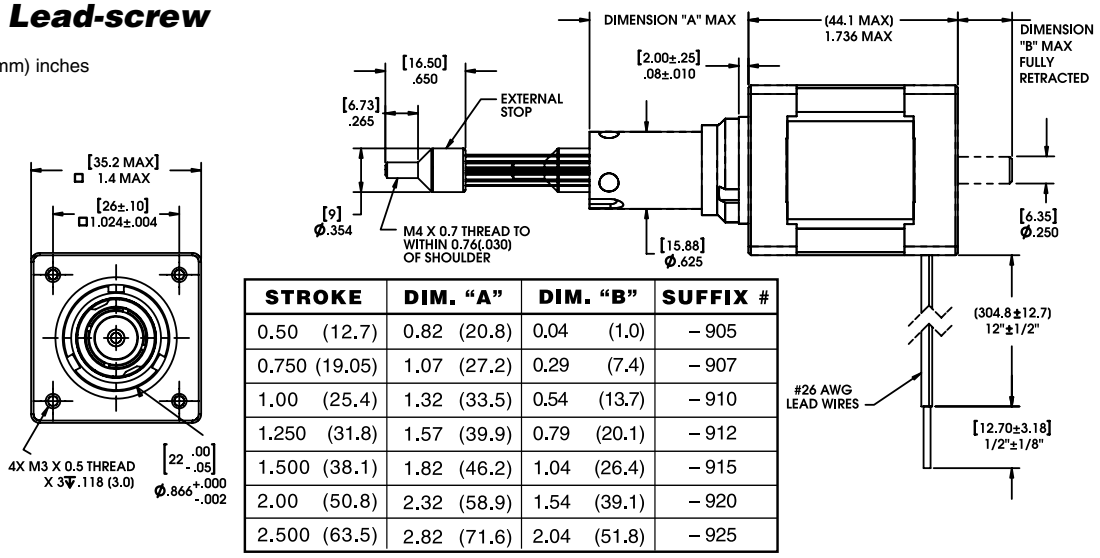
*– XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

## Captive Lead-screw

Dimensions = (mm) inches



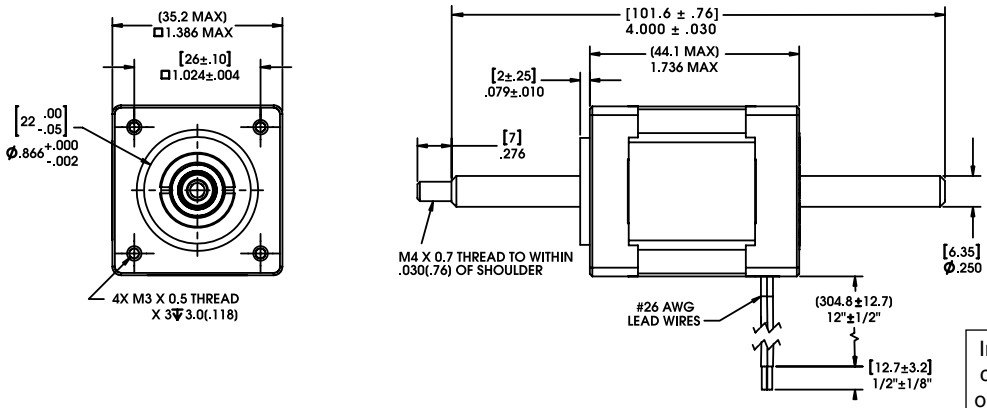

| STROKE | DIM. "A" | DIM. "B" | SUFFIX # |
|---|---|---|---|
| 0.50 (12.7) | 0.82 (20.8) | 0.04 (1.0) | – 905 |
| 0.750 (19.05) | 1.07 (27.2) | 0.29 (7.4) | – 907 |
| 1.00 (25.4) | 1.32 (33.5) | 0.54 (13.7) | – 910 |
| 1.250 (31.8) | 1.57 (39.9) | 0.79 (20.1) | – 912 |
| 1.500 (38.1) | 1.82 (46.2) | 1.04 (26.4) | – 915 |
| 2.00 (50.8) | 2.32 (58.9) | 1.54 (39.1) | – 920 |
| 2.500 (63.5) | 2.82 (71.6) | 2.04 (51.8) | – 925 |

Integrated connector option, see page 117

## Non-Captive Lead-screw

Dimensions = (mm) inches

Up to 6-in (152 mm) standard screw lengths. Longer screw lengths are available.

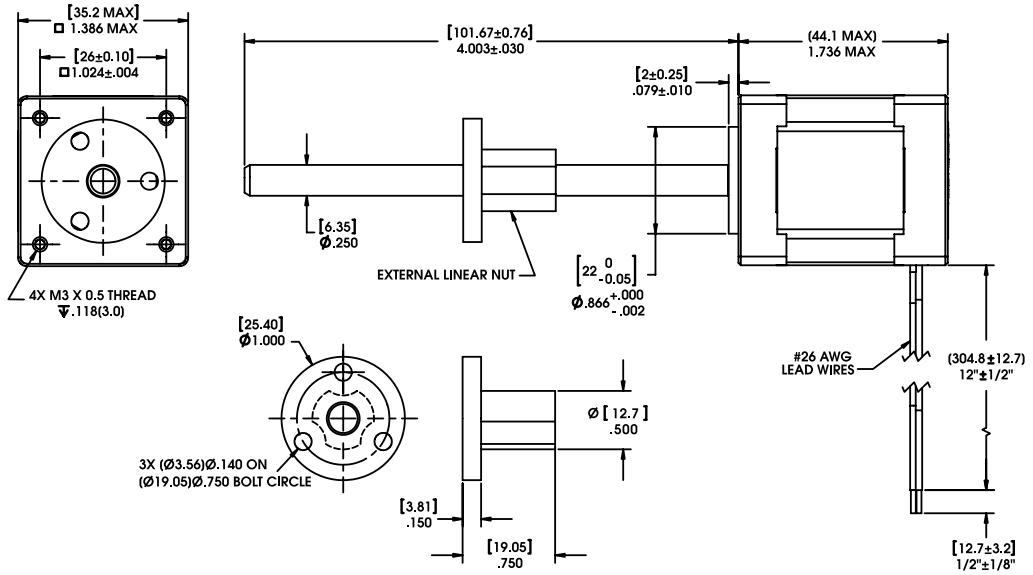



Integrated connector option, see page 117

## External Linear

Dimensions = (mm) inches

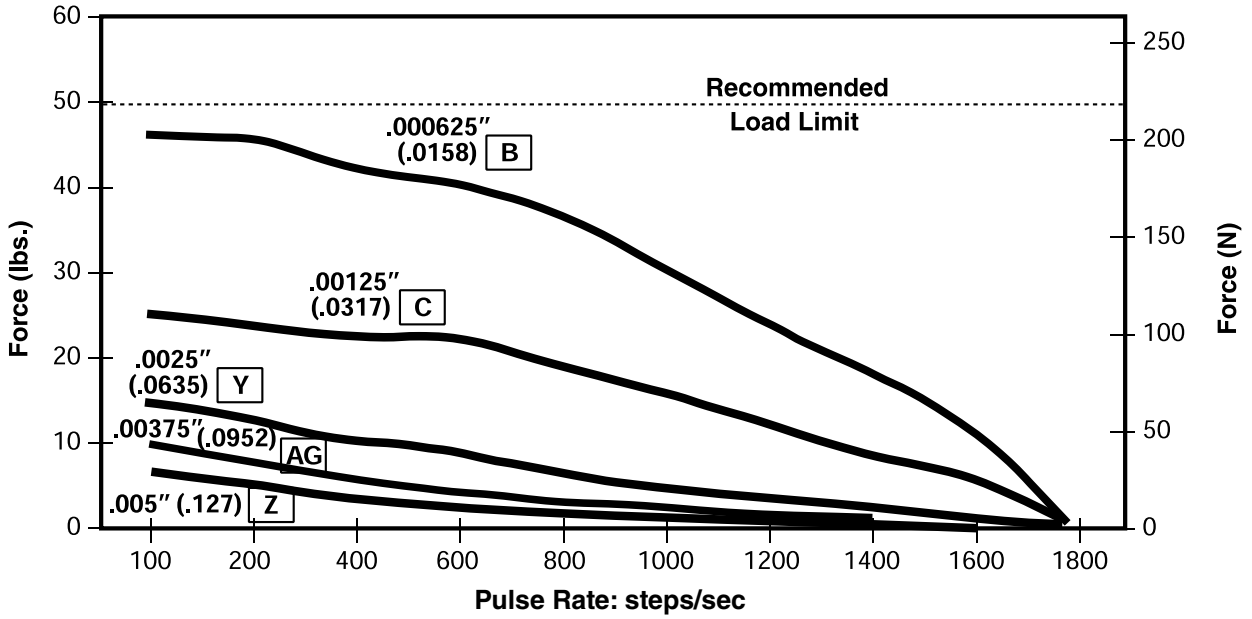
Up to 6-in (152 mm) standard screw lengths. Longer screw lengths are available.




Integrated connector option, see page 117

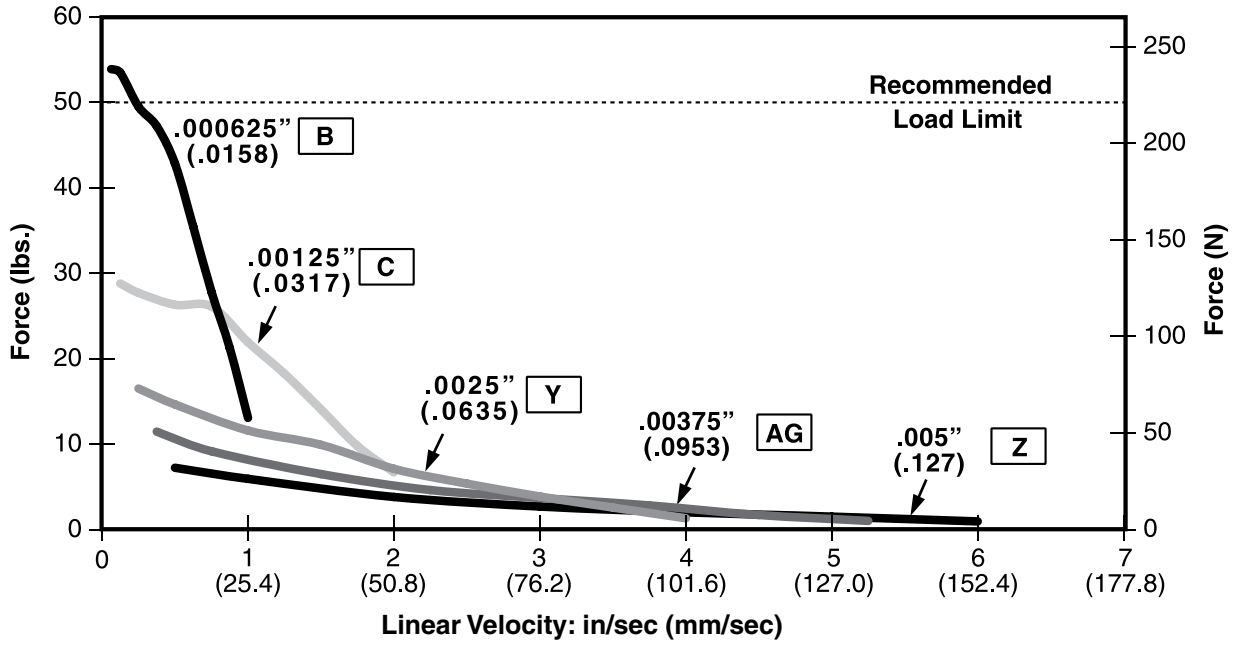
## FORCE vs. PULSE RATE

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .250 (6.35) Lead-screw**




## FORCE vs. LINEAR VELOCITY

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .250 (6.35) Lead-screw**




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

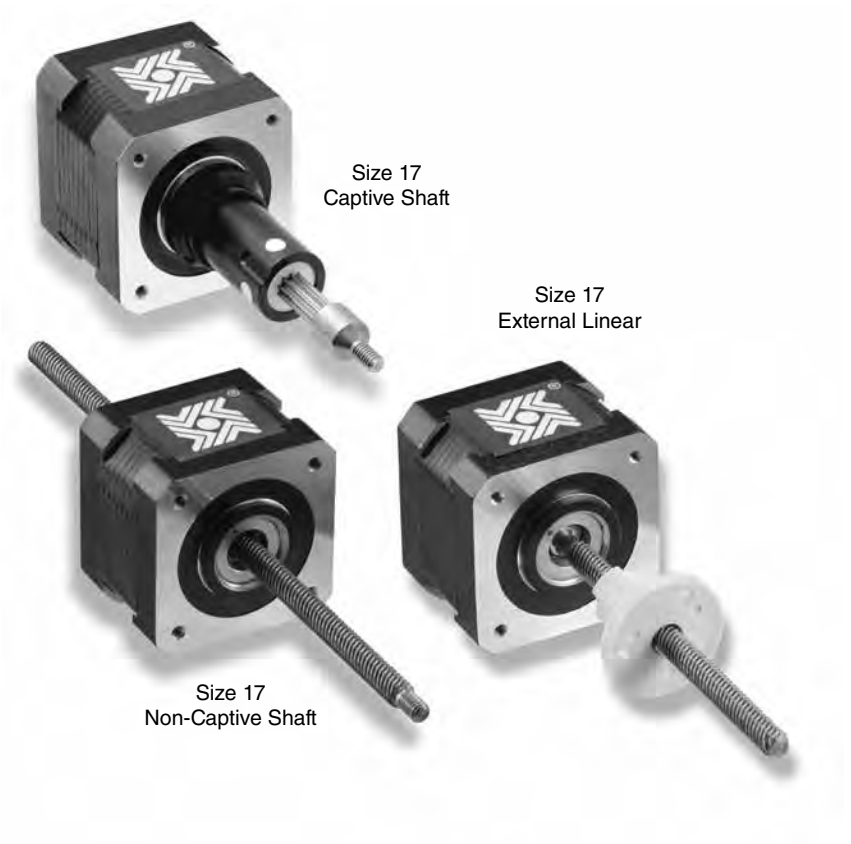
Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## Haydon® 43000 Series Size 17 hybrid linear actuators are our best selling compact hybrid motors.

These top selling designs deliver high performance, opening avenues for equipment designers who previously settled for products with inferior performance and endurance.

Three designs are available, captive, non-captive and external linear versions. The 43000 Series is available in a wide variety of resolutions - from 0.00006-in. (.001524 mm) per step to 0.00192-in. (.048768 mm) per step - and delivers thrust of up to 50 lbs. (222 N), or speeds exceeding 3 inches (7.62 cm) per second.




## Specifications

| Size 17: 43 mm (1.7-in) Hybrid Linear Actuator (1.8° Step Angle) | | | | | | |
|---|---|---|---|---|---|---|
| Part No. | Captive | 43H4□-□□-□□□† | | | 43H6□-□□-□□□† | |
| | Non-captive | 43F4□-□□-□□□† | | | 43F6□-□□-□□□† | |
| | External Lin. | E43H4□-□□-□□□† | | | E43H6□-□□-□□□† | |
| Wiring | | Bipolar | | | Unipolar** | |
| Winding Voltage | | 2.33 VDC | 5 VDC | 12 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 1.5 A | 700 mA | 290 mA | 700 mA | 290 mA |
| Resistance/phase | | 1.56 Ω | 7.2 Ω | 41.5 Ω | 7.2 Ω | 41.5 Ω |
| Inductance/phase | | 1.9 mH | 8.7 mH | 54.0 mH | 4.4 mH | 27.0 mH |
| Power Consumption | | 7 W | | | | |
| Rotor Inertia | | 37 gcm² | | | | |
| Insulation Class | | Class B (Class F available) | | | | |
| Weight | | 8.5 oz (241 g) | | | | |
| Insulation Resistance | | 20 MΩ | | | | |

| Linear Travel / Step | | | | | |
|---|---|---|---|---|---|
| Screw Ø .218" (5.54 mm) inches | mm | Order Code I.D. | Screw Ø .250" (6.35 mm) inches | mm | Order Code I.D. |
| .00012 | .0030* | N | .00015625 | .0039* | P |
| .00024 | .0060* | K | .0003125 | .0079* | A |
| .00048 | .0121* | J | .000625 | .0158* | B |
| .00096 | .0243* | Q | .00125 | .0317* | C |
| .00192 | .0487* | R | | | |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C. Also available, motors with high temperature capability windings up to 155°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

†Part numbering information on page 96.

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

## *Identifying the Hybrid part number codes when ordering*

Haydon kerk Express℠
*www.HaydonKerkExpress.com*
Standard products available 24-hrs.

| E | 43 | H | 6 | N | – | 2.33 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix***
(include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**43 = 43000**

(Series numbers represent approximate width of motor body)

***Style***

**F** = 1.8° Non-captive
**H** = 1.8° Captive or External (use "E" or "K" Prefix for External version)
**J** = 0.9° Non-captive
**K** = 0.9° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)
**6** = Unipolar (6 wire)

**G** = IDEA Drive (Size 17, 43000 Series, Bipolar only)

***Code ID Resolution Travel/Step***

**N** = .00012-in (.0030)
**K** = .00024-in (.0060)
**J** = .00048-in (.0121)
**Q** = .00096-in (.0243)
**P** = .00015625-in (.0039)
**A** = .0003125-in (.0079)
**B** = .000625-in (.0158)
**C** = .00125-in (.0317)
**R** = .00192-in (.0478)

**High Resolution**

**U** = .00006-in (.0015)
**V** = .000078-in (.00198)

***Voltage***

**2.33** = 2.33 VDC
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 97.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

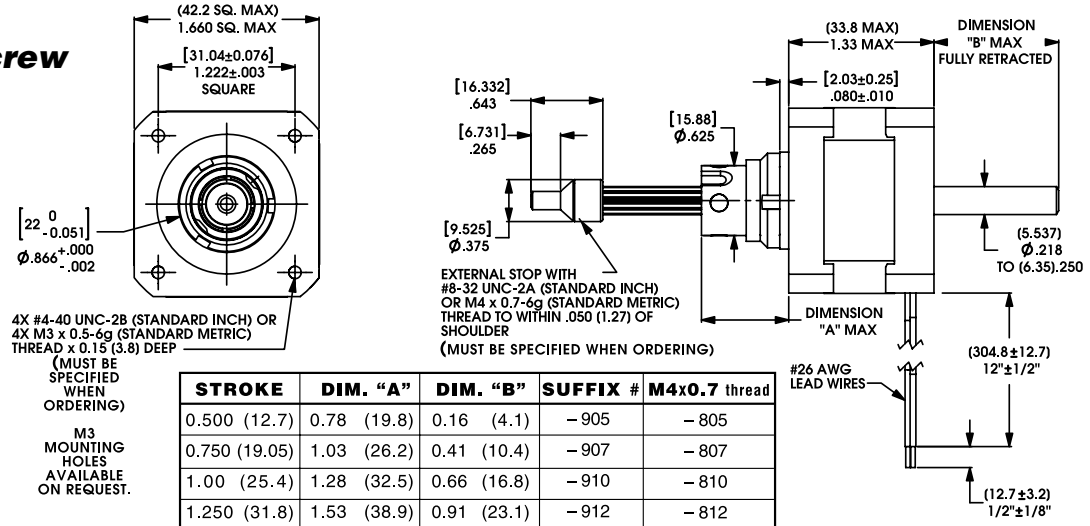
*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

## Captive Lead-screw

Dimensions = (mm) inches



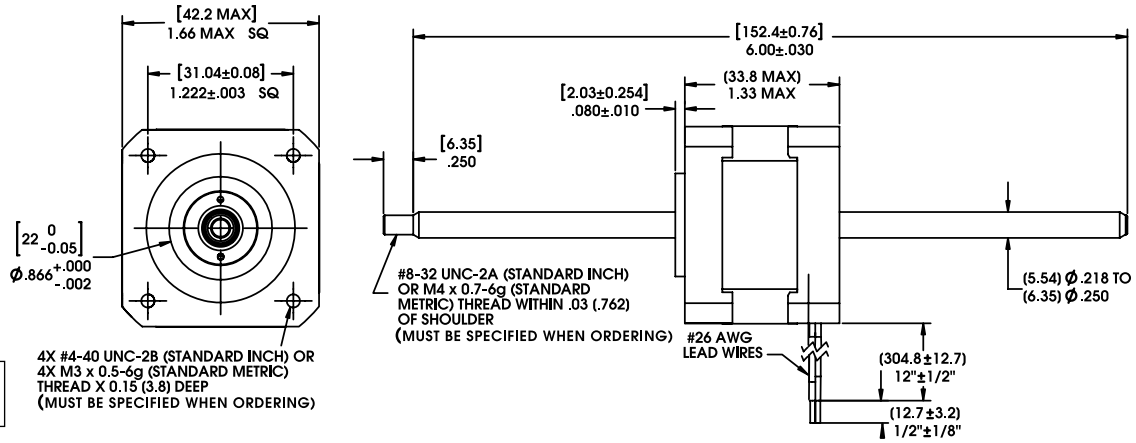

| STROKE | DIM. "A" | DIM. "B" | SUFFIX # | M4x0.7 thread |
|---|---|---|---|---|
| 0.500 (12.7) | 0.78 (19.8) | 0.16 (4.1) | – 905 | – 805 |
| 0.750 (19.05) | 1.03 (26.2) | 0.41 (10.4) | – 907 | – 807 |
| 1.00 (25.4) | 1.28 (32.5) | 0.66 (16.8) | – 910 | – 810 |
| 1.250 (31.8) | 1.53 (38.9) | 0.91 (23.1) | – 912 | – 812 |
| 1.500 (38.1) | 1.78 (45.2) | 1.16 (29.5) | – 915 | – 815 |
| 2.00 (50.8) | 2.28 (57.9) | 1.66 (42.2) | – 920 | – 820 |
| 2.500 (63.5) | 2.78 (70.6) | 2.16 (54.9) | – 925 | – 825 |

Integrated connector option, see page 117

## Non-Captive Lead-screw

Dimensions = (mm) inches

Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.

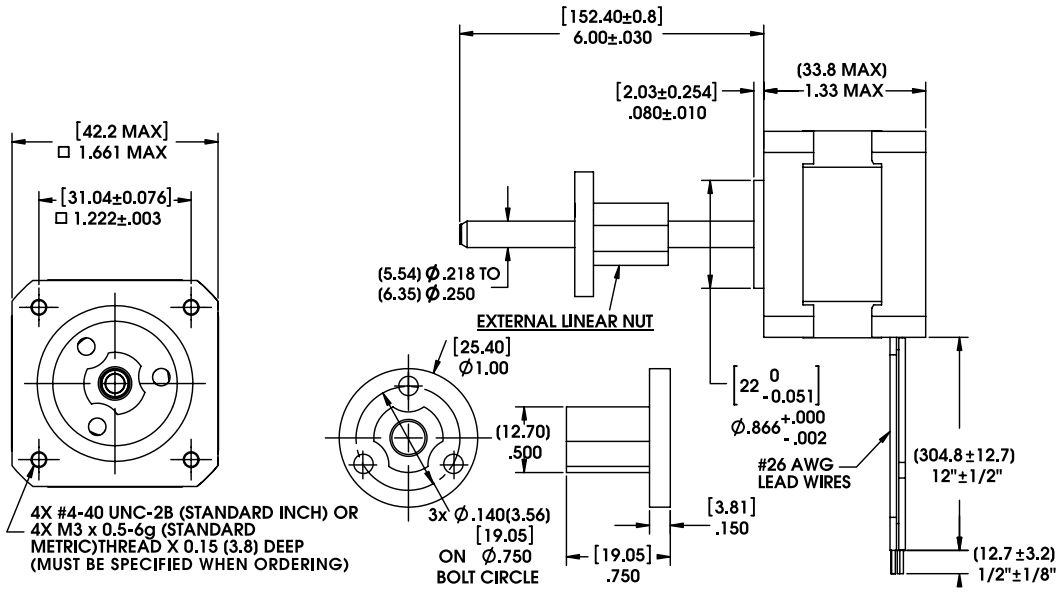



Integrated connector option, see page 117

## External Linear

Dimensions = (mm) inches

Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.




Integrated connector option, see page 117

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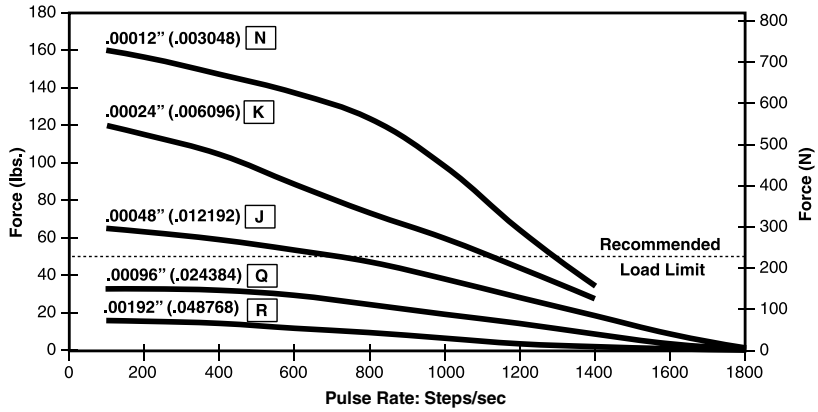
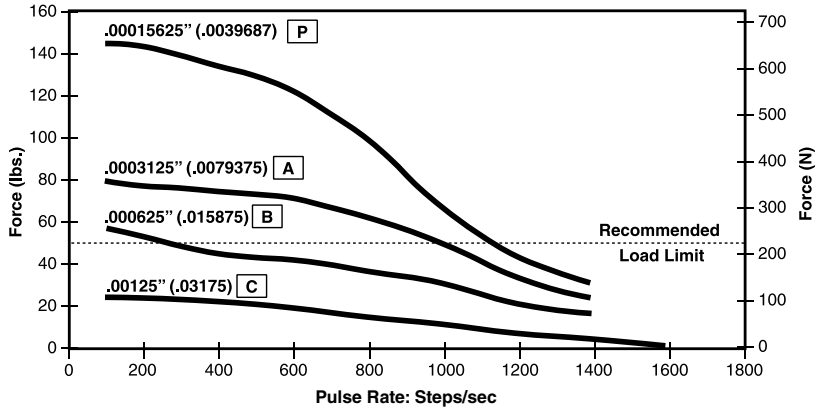
## FORCE vs. PULSE RATE

- Chopper
- Bipolar
- 100% Duty Cycle
- 8:1 Motor Coil to Drive Supply Voltage

**Ø .218 (5.54) Lead-screw >**



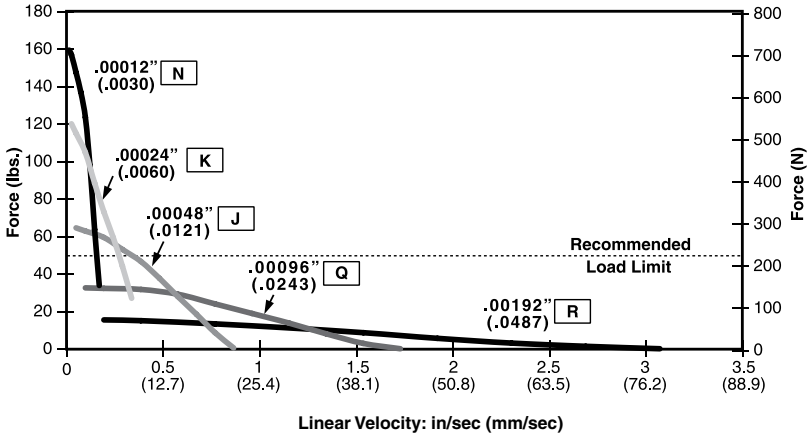

**Ø .250 (6.35) Lead-screw >**



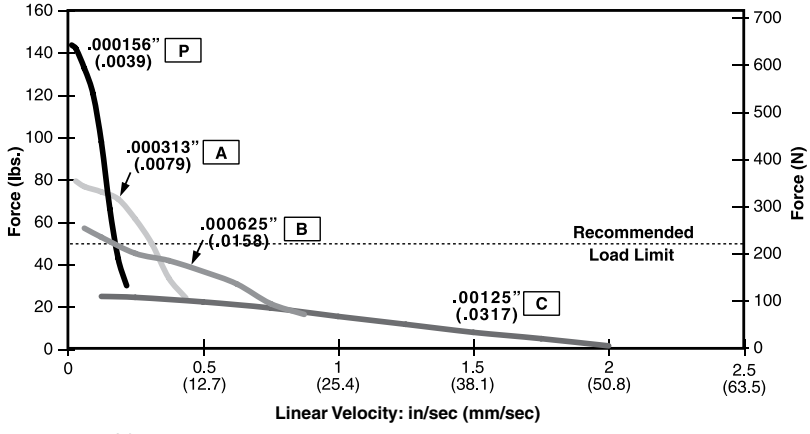

## FORCE vs. LINEAR VELOCITY

- Chopper
- Bipolar
- 100% Duty Cycle
- 8:1 Motor Coil to Drive Supply Voltage

**Ø .218 (5.54) Lead-screw >**




**Ø .250 (6.35) Lead-screw >**




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## The Haydon® 43000 Series Size 17, 0.9° High Resolution Motor

The Size 17 High Resolution Actuator features a production-proven, patented rotor drive nut that delivers trouble-free, long-term performance.

## Specifications

| Size 17: 43 mm (1.7-in) Hybrid Linear Actuator (0.9° Step Angle) | | | | | |
|---|---|---|---|---|---|
| Captive | 43K4 ■–■■–■■■† | | | 43K6 ■–■■–■■■† | |
| Non-captive | 43J4 ■–■■–■■■† | | | 43J6 ■–■■–■■■† | |
| External Lin. | E43K4 ■–■■–■■■† | | | E43K6 ■–■■–■■■† | |
| Wiring | Bipolar | | | Unipolar** | |
| Winding Voltage | 2.33 VDC | 5 VDC | 12 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | 1.5 A | 700 mA | 290 mA | 700 mA | 290 mA |
| Resistance/phase | 1.56 Ω | 7.2 Ω | 41.5 Ω | 7.2 Ω | 41.5 Ω |
| Inductance/phase | 2.6 mH | 12.0 mH | 70.0 mH | 6.0 mH | 35.0 mH |
| Power Consumption | 7 W | | | | |
| Rotor Inertia | 37 gcm$^2$ | | | | |
| Insulation Class | Class B (Class F available) | | | | |
| Weight | 8.5 oz (241 g) | | | | |
| Insulation Resistance | 20 MΩ | | | | |

| Linear Travel / Step | | | | | |
|---|---|---|---|---|---|
| Screw Ø .218" (5.54 mm) inches | mm | Order Code I.D. | Screw Ø .250" (6.35 mm) inches | mm | Order Code I.D. |
| .00006 | .0015* | U | .000078* | .00198* | V |
| .00012 | .0030* | N | .00015625 | .0039* | P |
| .00024 | .0060* | K | .0003125 | .0079* | A |
| .00048 | .0121* | J | .000625 | .0158* | B |
| .00096 | .0243* | Q | | | |

*Values truncated

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

NOTE: Refer to performance curves on page 98 for codes N, K, J, Q, P, A, B

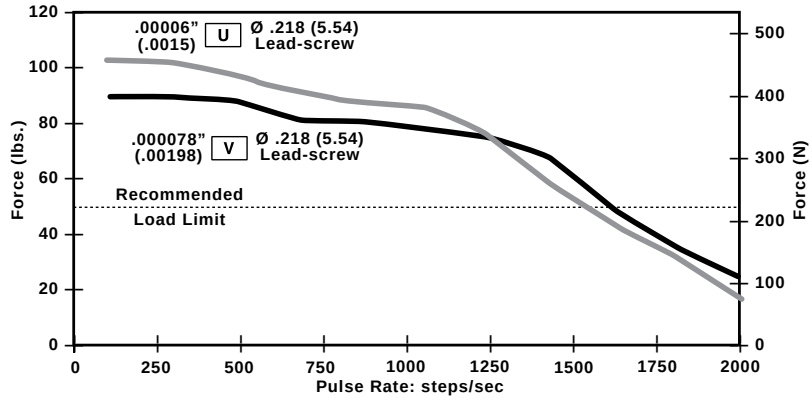
† Part numbering information on page 96.

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

### *FORCE vs. PULSE RATE*

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

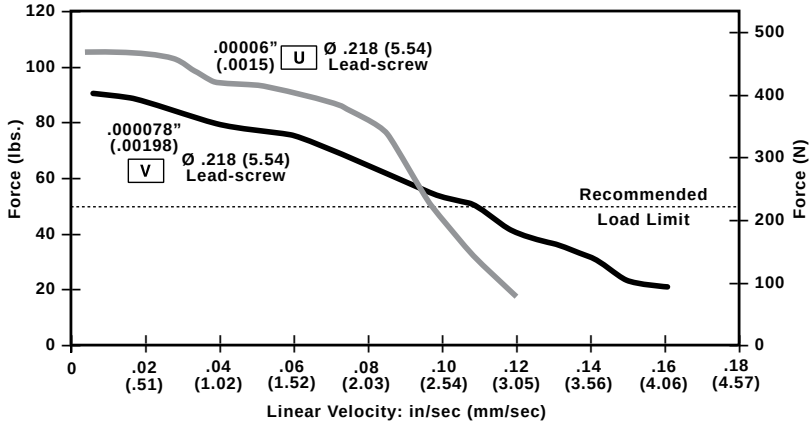
– with two available lead-screw diameters




### *FORCE vs. LINEAR VELOCITY*

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

– with two available lead-screw diameters




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

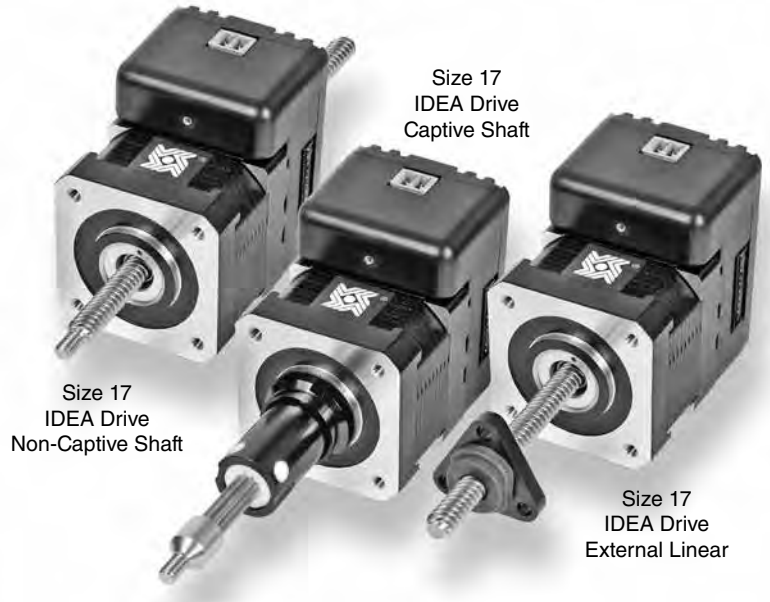
# The Haydon® 43000 Series Size 17 Hybrid Linear Actuators with integrated IDEA™ Drive – high performance in a compact package

The **43000 Series Single Stack actuator** is available in a wide variety of resolutions – from 0.00006-in (.001524 mm) per step to 0.00192-in (.048768mm) per step. Delivers output force of up to 50 lbs (220N), or speeds exceeding 3 inches (7.62 cm) per second.

**Programmable 43000 Series with IDEA™ Drive Features:**

- Fully Programmable
- RoHS Compliant
- USB or RS-485 Communication
- Microstepping Capability
  – Full, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64
- Graphic User Interface
- Auto-population of Drive Parameters
- Programmable Acceleration/Deceleration and Current Control

**Note:** For more information about the **IDEA™ Drive** see page 194.




## Single Stack Specifications

| **Size 17: 43 mm (1.7-in) Hybrid Linear Actuator** (1.8° Step Angle) | | |
|---|---|---|
| Part No. | Captive | 43HG ■–■■–■■■† |
| | Non-captive | 43FG ■–■■–■■■† |
| | External Lin. | E43HG ■–■■–■■■† |
| Wiring | | Bipolar |
| Winding voltage | | 2.33 VDC** |

| **Linear Travel / Step** | | | | | |
|---|---|---|---|---|---|
| Screw Ø .218" (5.54 mm) inches | mm | **Order Code I.D.** | Screw Ø .250" (6.35 mm) inches | mm | **Order Code I.D.** |
| .00012 | .0030* | N | .00015625 | .0039* | P |
| .00024 | .0060* | K | .0003125 | .0079* | A |
| .00048 | .0121* | J | .000625 | .0158* | B |
| .00096 | .0243* | Q | .00125 | .0317* | C |
| .00192 | .0487* | R | | | |

*Values truncated

† Part numbering information on page 96.

**Contact Haydon Kerk if a higher voltage motor is desired.

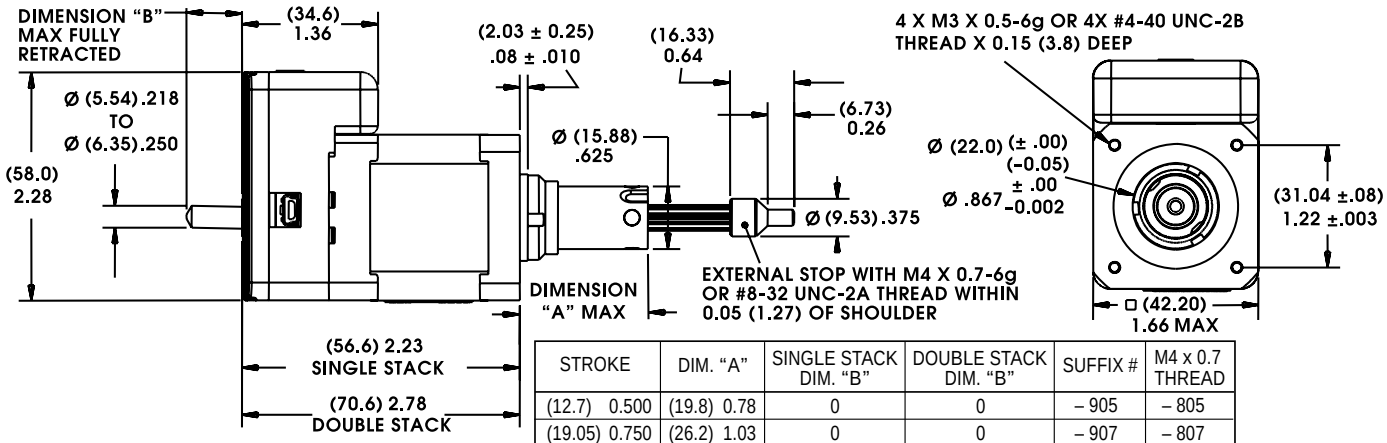
Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

## IDEA™ Drive software is simple to use with on-screen buttons and easy-to-understand programming guides.

The software program generates motion profiles directly into the system and also contains a "debug" utility allowing line-by-line execution of a motion program for easy troubleshooting.

## Captive Lead-screw

Dimensions = (mm) inches

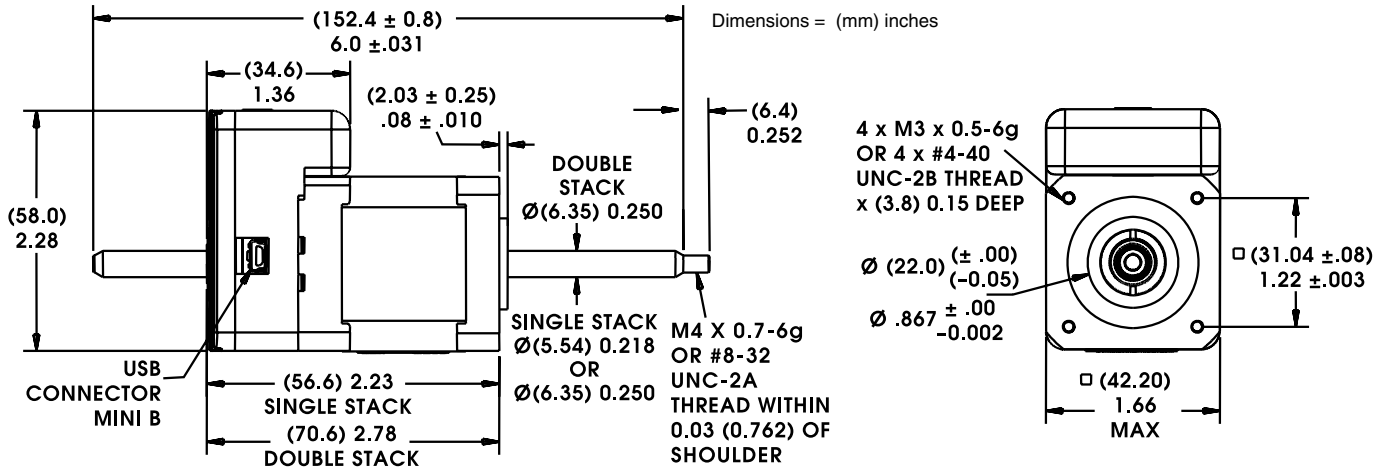



| STROKE | DIM. "A" | SINGLE STACK DIM. "B" | DOUBLE STACK DIM. "B" | SUFFIX # | M4 x 0.7 THREAD |
|---|---|---|---|---|---|
| (12.7) 0.500 | (19.8) 0.78 | 0 | 0 | – 905 | – 805 |
| (19.05) 0.750 | (26.2) 1.03 | 0 | 0 | – 907 | – 807 |
| (25.4) 1.00 | (32.5) 1.28 | 0 | 0 | – 910 | – 810 |
| (31.8) 1.250 | (38.9) 1.53 | 0 | 0 | – 912 | – 812 |
| (38.1) 1.500 | (45.2) 1.78 | (5.9) 0.232 | (2.5) 0.091 | – 915 | – 815 |
| (50.8) 2.00 | (57.9) 2.28 | (18.6) 0.732 | (15.0) 0.591 | – 920 | – 820 |
| (63.5) 2.500 | (70.6) 2.78 | (31.3) 1.232 | (27.7) 1.091 | – 925 | – 825 |

## Non-Captive Lead-screw

Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.

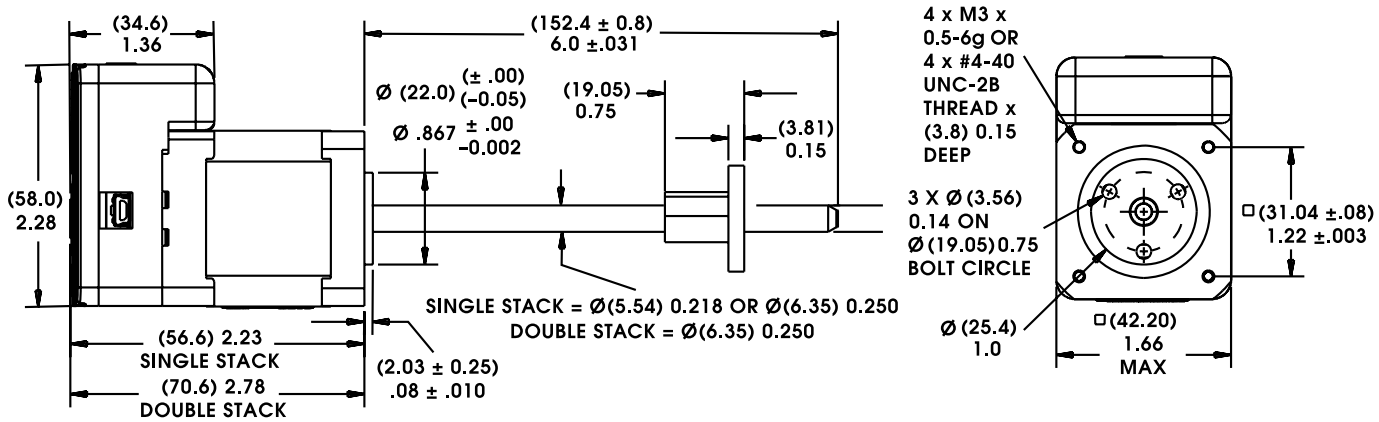
Dimensions = (mm) inches




## External Linear

Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.

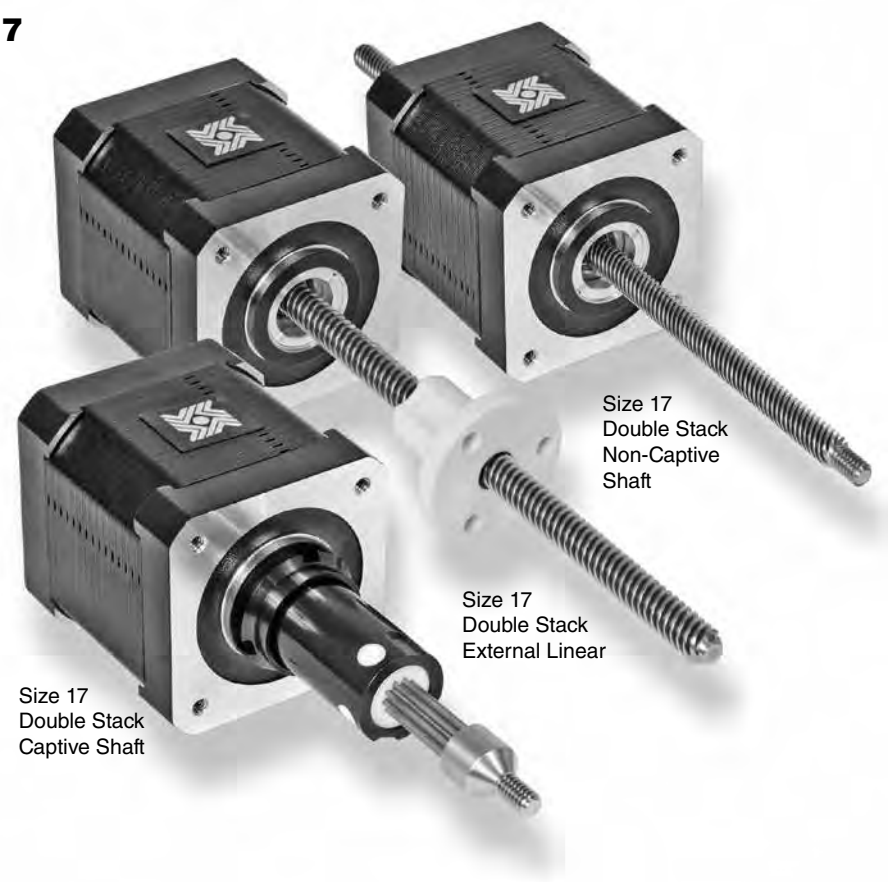
Dimensions = (mm) inches



## Haydon® 43000 Series Size 17 Double Stack hybrid linear actuators offer greater performance.

The versatile designs deliver exceptional performance and new linear motion design opportunities.

Three designs are available, captive, non-captive and external linear versions. The 43000 Series is available in a wide variety of resolutions – from 0.000625-in (.0158 mm) per step to 0.005-in (.127 mm) per step. The motors can also be microstepped for even finer resolutions. The Size 17 Double Stack actuator delivers thrust of up to 75 lbs. (337 N).




## Specifications

| Size 17: 43 mm (1.7-in) Double Stack Hybrid **Linear Actuator** (1.8° Step Angle) | | | | |
|---|---|---|---|---|
| Part No. | Captive | 43M4 ■–■■–■■■† | | |
| | Non-captive | 43L4 ■–■■–■■■† | | |
| | External Lin. | E43M4 ■–■■–■■■† | | |
| Wiring | | Bipolar | | |
| Winding Voltage | | 2.33 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 2.6 A | 1.3 A | 550 mA |
| Resistance/phase | | 0.9 Ω | 3.8 Ω | 21.9 Ω |
| Inductance/phase | | 1.33 mH | 8.21 mH | 45.1 mH |
| Power Consumption | | 10.4 W Total | | |
| Rotor Inertia | | 78 gcm$^2$ | | |
| Insulation Class | | Class B (Class F available) | | |
| Weight | | 12.5 oz (352 g) | | |
| Insulation Resistance | | 20 MΩ | | |

† Part numbering information on page 103.

| **Linear Travel / Step** Screw Ø.250" (6.35 mm) inches | mm | **Order Code I.D.** |
|---|---|---|
| .000625 | .0158* | B |
| .00125 | .0317* | C |
| .0025 | .0635 | Y |
| .00375 | .0953 | AG |
| .005 | .127 | Z |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

## Identifying the Hybrid part number codes when ordering

| E | 43 | M | G | N | – | 2.33 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix***
(include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**43 = 43000**

(Series numbers represent approximate width of motor body)

***Style***

**L** = 1.8° Non-captive
**M** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)
**G** = IDEA Drive (Size 17, 43000 Series, Bipolar only)

***Code ID Resolution Travel/Step***

**B** = .000625-in (.0158)
**C** = .00125-in (.0317)
**Y** = .0025-in (.0635)
**AG** = .00375-in (.0953)
**Z** = .005-in (.127)

***Voltage***

**2.33** = 2.33 VDC
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 104.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

Haydon kerk Express℠
www.HaydonKerkExpress.com
Standard products available 24-hrs.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

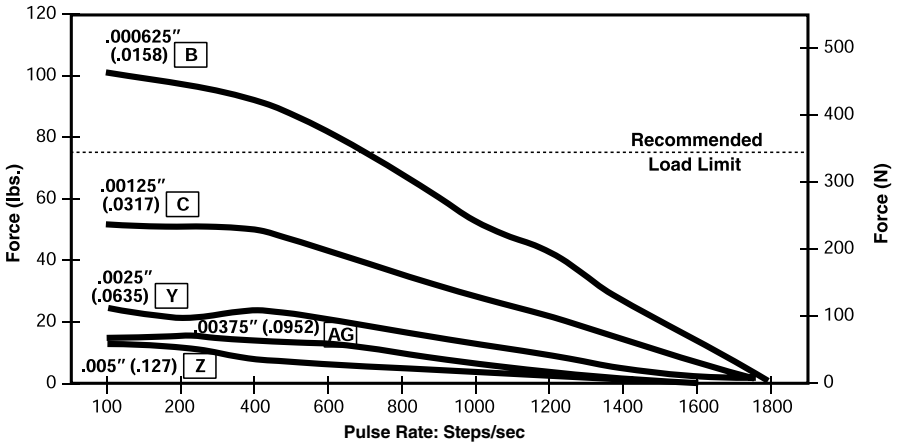


## 43000 Series: Size 17 Double Stack Performance Curves

### FORCE vs. PULSE RATE

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

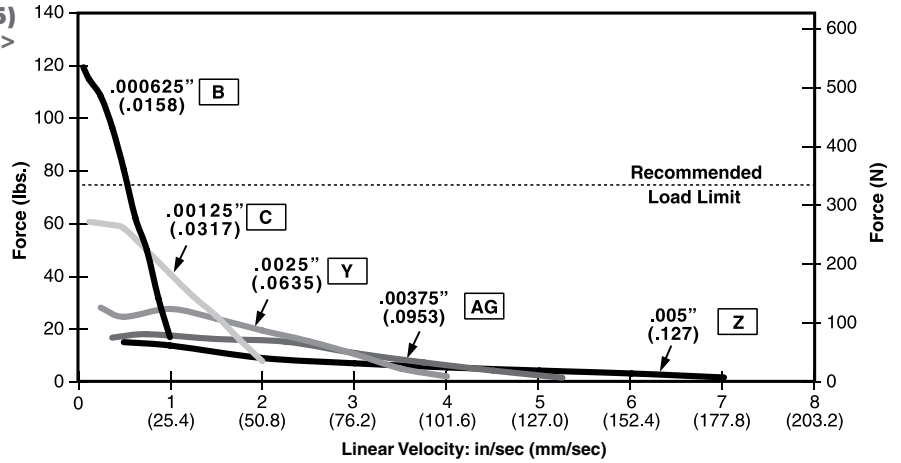
**Ø .250 (6.35) Lead-screw >**




### FORCE vs. LINEAR VELOCITY

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

**Ø .250 (6.35) Lead-screw >**



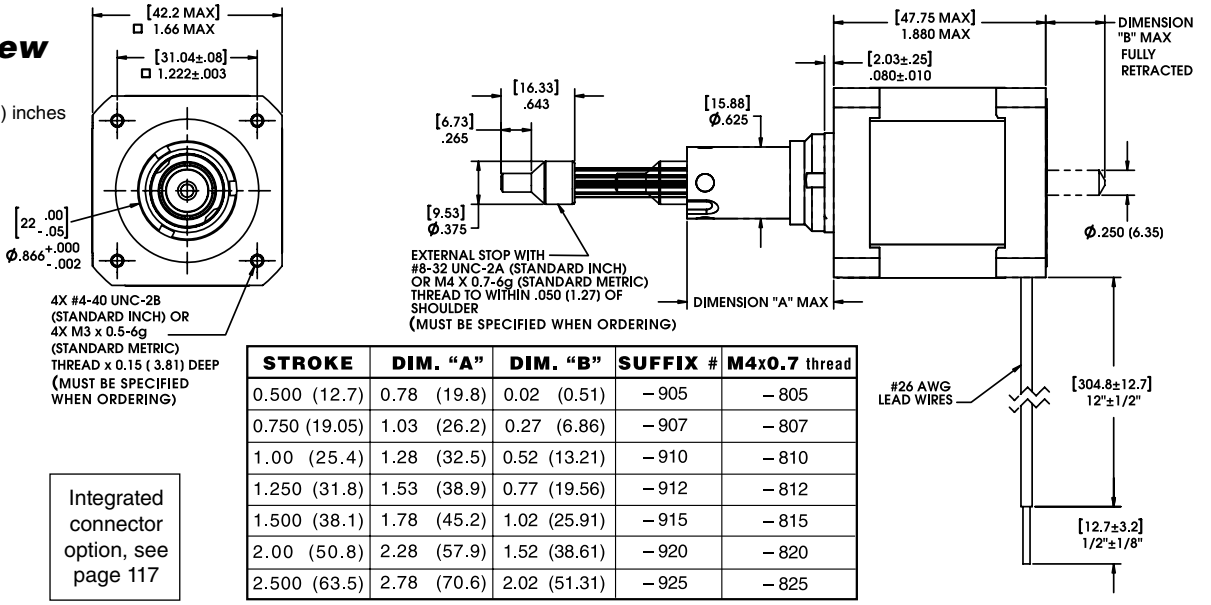

NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## Captive Lead-screw

Dimensions = (mm) inches




| STROKE | DIM. "A" | DIM. "B" | SUFFIX # | M4x0.7 thread |
|---|---|---|---|---|
| 0.500 (12.7) | 0.78 (19.8) | 0.02 (0.51) | –905 | –805 |
| 0.750 (19.05) | 1.03 (26.2) | 0.27 (6.86) | –907 | –807 |
| 1.00 (25.4) | 1.28 (32.5) | 0.52 (13.21) | –910 | –810 |
| 1.250 (31.8) | 1.53 (38.9) | 0.77 (19.56) | –912 | –812 |
| 1.500 (38.1) | 1.78 (45.2) | 1.02 (25.91) | –915 | –815 |
| 2.00 (50.8) | 2.28 (57.9) | 1.52 (38.61) | –920 | –820 |
| 2.500 (63.5) | 2.78 (70.6) | 2.02 (51.31) | –925 | –825 |

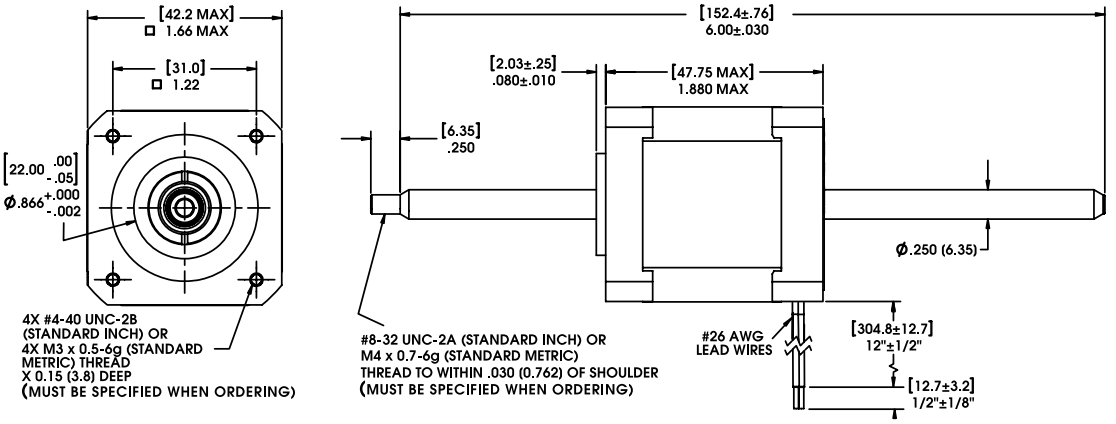
Integrated connector option, see page 117

## Non-Captive Lead-screw

Dimensions = (mm) inches

Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.

Integrated connector option, see page 117

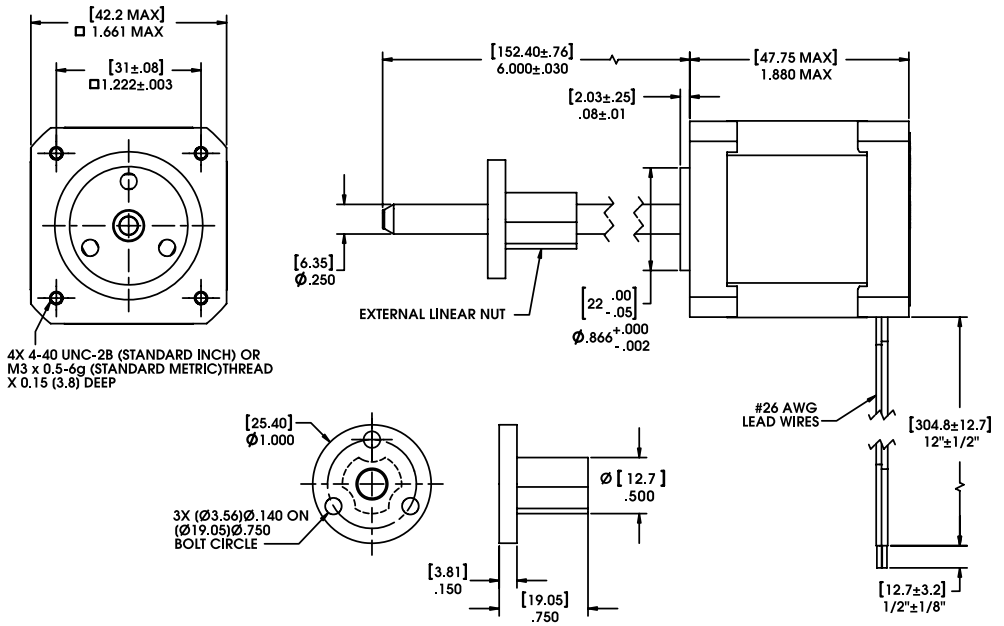



## External Linear

Dimensions = (mm) inches

Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.

Integrated connector option, see page 117



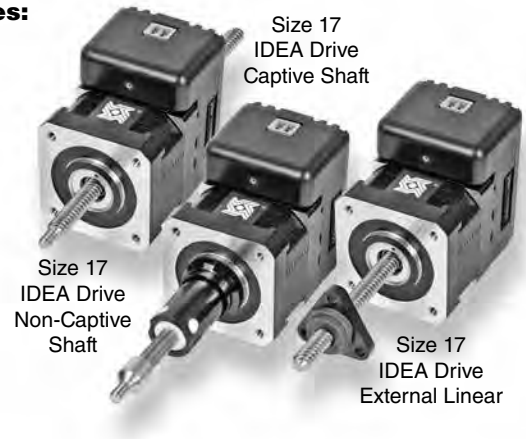
## The Haydon® 43000 Series Size 17 Double Stack Hybrid Linear Actuators with integrated IDEA™ Drive – programmable, improved performance

The **43000 Series Double Stack actuator** is available in a wide variety of resolutions – from 0.000625-in (.0158 mm) per step to 0.005-in (.127 mm) per step. Delivers output force of up to 75 lbs (337N).

**Programmable IDEA™ Drive Features:**

- Fully Programmable
- RoHS Compliant
- USB or RS-485 Communication
- Microstepping Capability
  – Full, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64
- Graphic User Interface
- Auto-population of Drive Parameters
- Programmable Acceleration/Deceleration and Current Control

**Note:** See page 194 for more information on the IDEA™ Drive




**Dimensional Drawings**
See page 101.

## Double Stack Specifications

| **Size 17 DS: 43 mm (1.7-in) Hybrid Linear Actuator** (1.8° Step Angle) | | |
|---|---|---|
| Part No. | Captive | 43MG ■–■■–■■■ |
| | Non-captive | 43LG ■–■■–■■■ |
| | External Lin. | E43MG ■–■■–■■■ |
| Wiring | | Bipolar |
| Winding voltage | | 2.33 VDC** |

| **Linear Travel / Step** Screw Ø .250" (6.35 mm) inches | mm | **Order Code I.D.** |
|---|---|---|
| .000625 | .0158* | B |
| .00125 | .0317* | C |
| .0025 | .0635* | Y |
| .00375 | .0953* | AG |
| .005 | .127* | Z |

*Values truncated

**Contact Haydon Kerk if a higher voltage motor is desired.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

## *Identifying the Hybrid part number codes when ordering*

| E | 43 | M | G | N | – | 2.33 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix*** (include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**43 = 43000**

(Series numbers represent approximate width of motor body)

***Style***

**L** = 1.8° Non-captive
**M** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)
**G** = IDEA Drive (Size 17, 43000 Series, Bipolar only)

***Code ID Resolution Travel/Step***

**B** = .000625-in (.0158)
**C** = .00125-in (.0317)
**Y** = .0025-in (.0635)
**AG** = .00375-in (.0953)
**Z** = .005-in (.127)

***Voltage***

**2.33** = 2.33 VDC
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 104.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

Haydon kerk Express℠
*www.HaydonKerkExpress.com*
Standard products available 24-hrs.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

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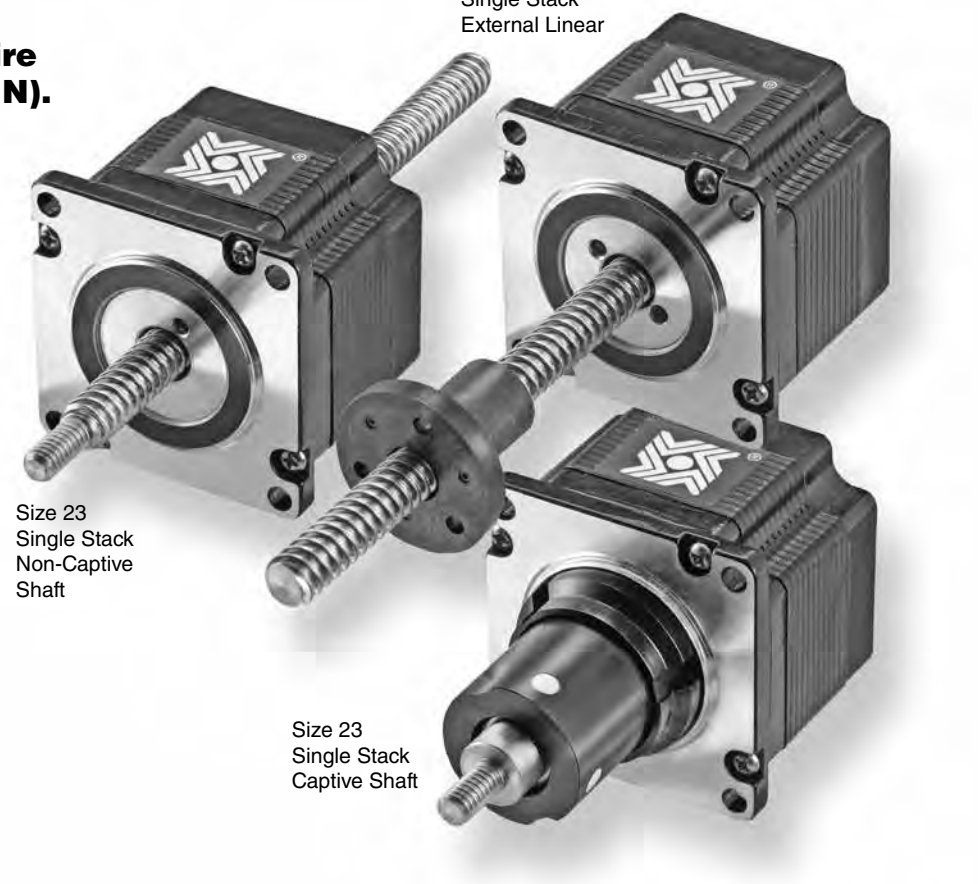
## Haydon® 57000 Series Size 23 hybrid linear actuators for applications that require forces up to 200 lbs. (890 N).

The Haydon® Size 23 incorporates the same high performance and durable design as the Size 17.

The 57000 Series Hybrid Linear Actuator is available in a wide variety of resolutions - from 0.0003125-in. (.0079375 mm) per step to 0.002-in. (.0508 mm) per step. They deliver a thrust of up to 200 lbs. (890 N) or speeds exceeding 2.0-in. (5.08 cm) per second.




## Specifications

| Size 23: 57 mm (2.3-in) Hybrid Linear Actuator (1.8° Step Angle) | | | | | | |
|---|---|---|---|---|---|---|
| Part No. | Captive | 57H4 ■–■■–■■■† | | | 57H6 ■–■■–■■■† | |
| | Non-captive | 57F4 ■–■■–■■■† | | | 57F6 ■–■■–■■■† | |
| | External Lin. | E57H4 ■–■■–■■■† | | | E57H6 ■–■■–■■■† | |
| Wiring | | Bipolar | | | Unipolar** | |
| Winding Voltage | | 3.25 VDC | 5 VDC | 12 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 2.0 A | 1.3 A | .54 A | 1.3 A | .54 A |
| Resistance/phase | | 1.63 Ω | 3.85 Ω | 22.2 Ω | 3.85 Ω | 22.2 Ω |
| Inductance/phase | | 3.5 mH | 10.5 mH | 58 mH | 5.3 mH | 23.6 mH |
| Power Consumption | | 13 W | | | | |
| Rotor Inertia | | 166 gcm$^2$ | | | | |
| Insulation Class | | Class B (Class F available) | | | | |
| Weight | | 18 oz (511 g) | | | | |
| Insulation Resistance | | 20 MΩ | | | | |

| Linear Travel / Step Screw Ø.375"(9.53 mm) inches | mm | Order Code I.D. |
|---|---|---|
| .0003125 | .0079* | A |
| .0004167 | .0105* | S |
| .0005 | .0127 | 3 |
| .0008333 | .0211* | T |
| .001 | .0254 | 1 |
| .002 | .0508 | 2 |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

† Part numbering information on page 107.

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

## Identifying the Hybrid part number codes when ordering

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www.HaydonKerkExpress.com
Standard products available 24-hrs.

| E | 57 | H | 6 | 7 | – | 3.25 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix*** (include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**57 = 57000**

(Series numbers represent approximate width of motor body)

***Style***

**F** = 1.8° Non-captive
**H** = 1.8° Captive or External (use "E" or "K" Prefix for External version)
**J** = 0.9° Non-captive
**K** = 0.9° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)
**6** = Unipolar (6 wire)

***Code ID Resolution Travel/Step***

**7** = .000125-in (.0031)
**S** = .0004167-in (.01058418)
**3** = .0005-in (.0127)
**1** = .001-in (.0254)
**A** = .0003125-in (.0079)
**T** = .0008333-in (.0211)
**2** = .002-in (.0508)

**High Resolution**

**P** = .00015625-in (.003969)
**X** = .00020833-in (.00529166)
**9** = .00025-in (.0635)

***Voltage***

**3.25** = 3.25 VDC
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 108.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

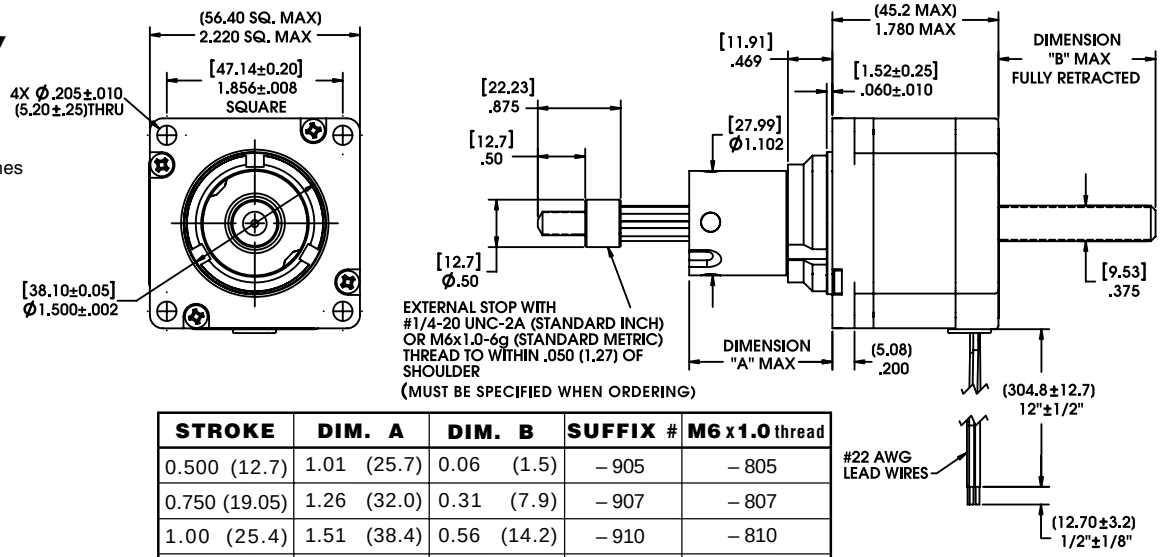
*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

**ENCODERS** and other **OPTIONAL ASSEMBLIES** also available

## Captive Lead-screw

Dimensions = (mm) inches

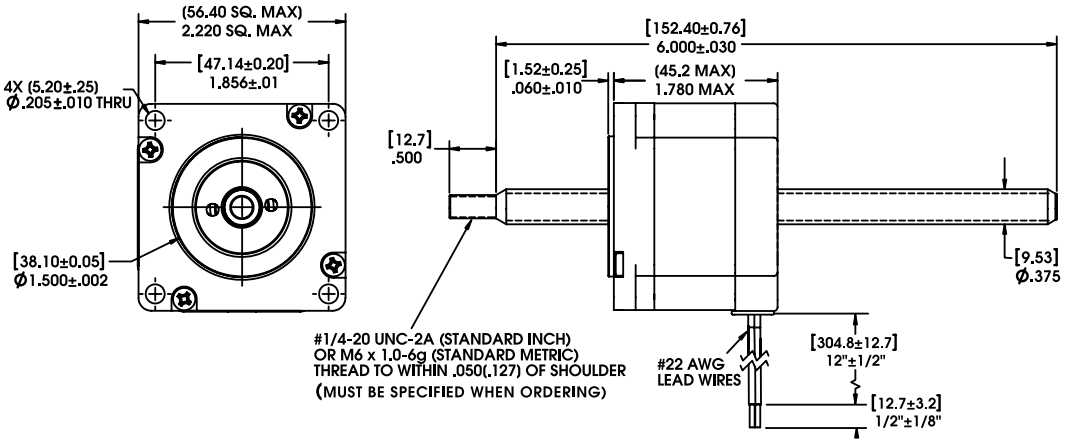



| STROKE | DIM. A | DIM. B | SUFFIX # | M6 x 1.0 thread |
|---|---|---|---|---|
| 0.500 (12.7) | 1.01 (25.7) | 0.06 (1.5) | – 905 | – 805 |
| 0.750 (19.05) | 1.26 (32.0) | 0.31 (7.9) | – 907 | – 807 |
| 1.00 (25.4) | 1.51 (38.4) | 0.56 (14.2) | – 910 | – 810 |
| 1.250 (31.8) | 1.76 (44.7) | 0.81 (20.6) | – 912 | – 812 |
| 1.500 (38.1) | 2.01 (51.1) | 1.06 (26.9) | – 915 | – 815 |
| 2.00 (50.8) | 2.51 (63.8) | 1.56 (39.6) | – 920 | – 820 |
| 2.500 (63.5) | 3.01 (76.5) | 2.06 (52.3) | – 925 | – 825 |

## Non-Captive Lead-screw

Dimensions = (mm) inches

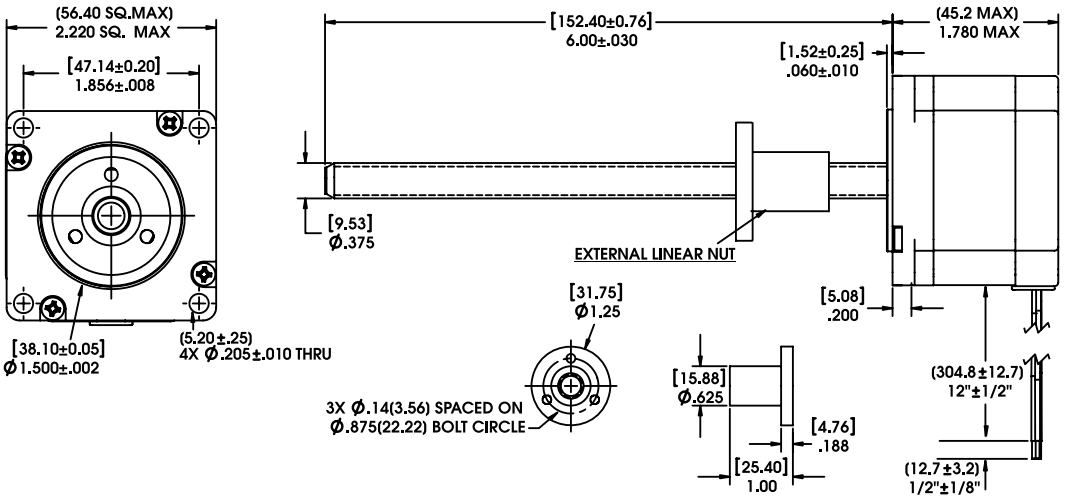
Up to 10-in (254 mm) standard screw lengths. Longer screw lengths are available.




## External Linear

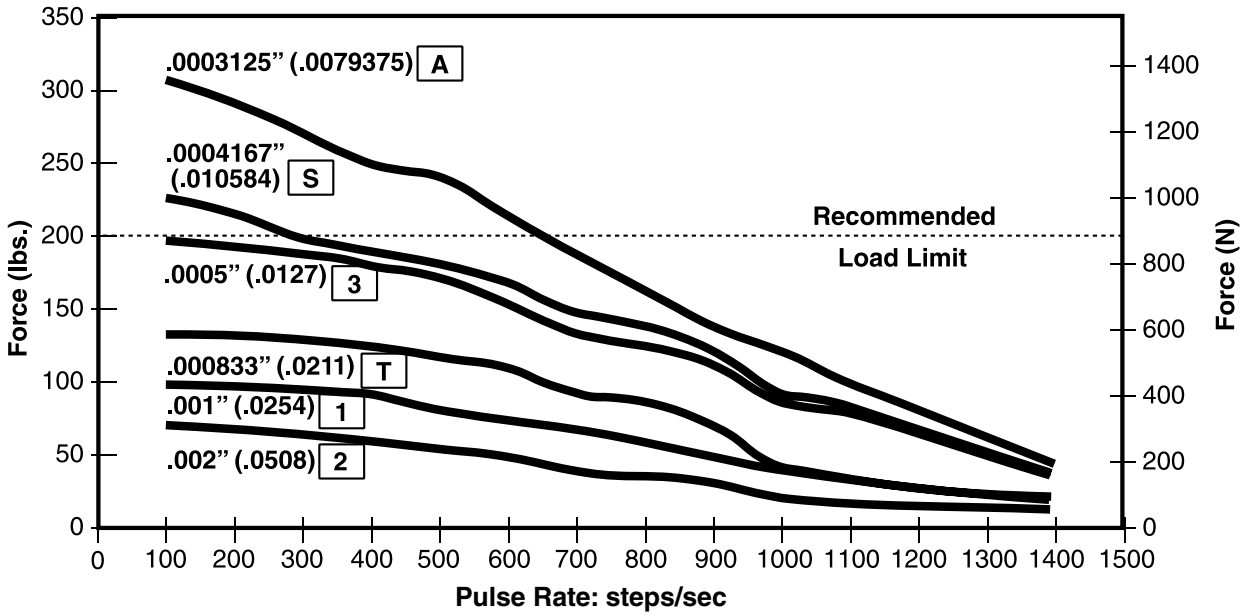
Dimensions = (mm) inches

Up to 12-in (305 mm) standard screw lengths. Longer screw lengths are available.



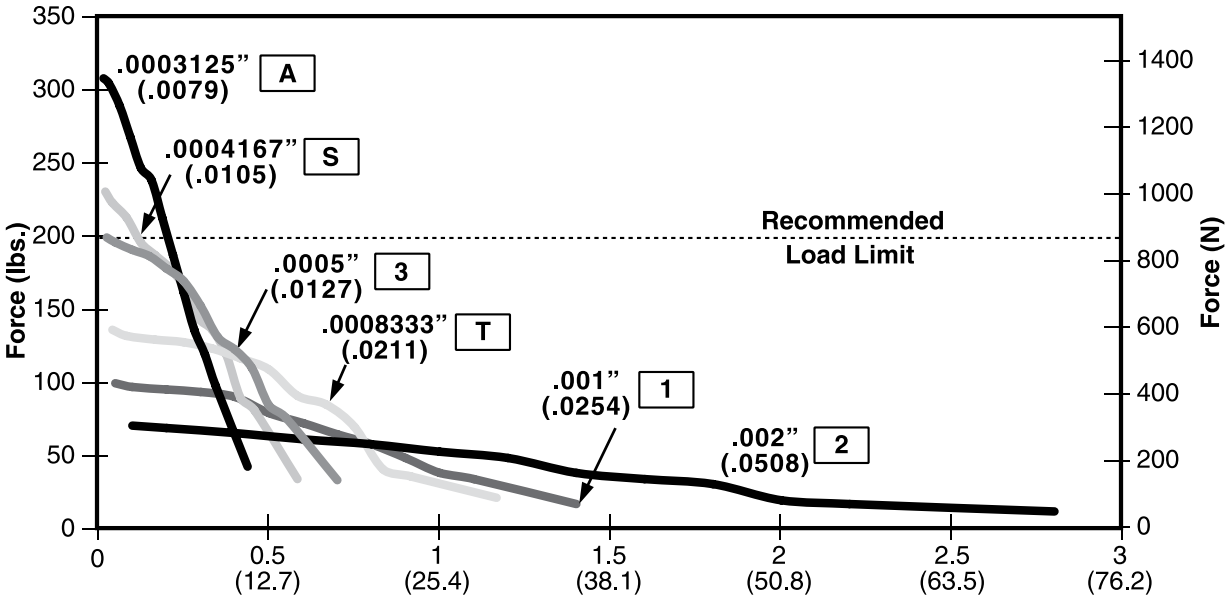
## FORCE vs. PULSE RATE

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .375 (9.53) Lead-screw**




## FORCE vs. LINEAR VELOCITY

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .375 (9.53) Lead-screw**




NOTE: All chopper drive curves were created with a 5 volt motor and a 75 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## The Haydon® 57000 Series Size 23, 0.9° High Resolution Motor

The Size 23, 0.9° high resolution hybrid offers precise, excellent motion control with a full linear step movement as low as 2 microns and a thrust capability up to 200 lbs (890 N).

## Specifications

| Size 23: 57 mm (2.3-in) Hybrid Linear Actuator (0.9° Step Angle) | | | | | | |
|---|---|---|---|---|---|---|
| Part No. | Captive | 57K4 ■-■■-■■■† | | | 57K6 ■-■■-■■■† | |
| | Non-captive | 57J4 ■-■■-■■■† | | | 57J6 ■-■■-■■■† | |
| | External Lin. | E57K4 ■-■■-■■■† | | | E57K6 ■-■■-■■■† | |
| Wiring | | †Bipolar | | | Unipolar** | |
| Winding Voltage | | 3.25 VDC | 5 VDC | 12 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 2.0 A | 1.3 A | 0.54 A | 1.3 A | 0.54 A |
| Resistance/phase | | 1.63 Ω | 3.85 Ω | 22.2 Ω | 3.85 Ω | 22.2 Ω |
| Inductance/phase | | 4.2 mH | 13 mH | 68 mH | 6 mH | 27 mH |
| Power Consumption | | 13 W | | | | |
| Rotor Inertia | | 166 gcm$^2$ | | | | |
| Insulation Class | | Class B (Class F available) | | | | |
| Weight | | 18 oz (511 g) | | | | |
| Insulation Resistance | | 20 MΩ | | | | |

| Linear Travel / Step Screw Ø.375"(9.53 mm) inches | mm | Order Code I.D. |
|---|---|---|
| .000125 | .0031* | 7 |
| .00015625 | .003969 | P |
| .00020833 | .00529166 | X |
| .00025 | .00635 | 9 |
| .0004167 | .01058418 | S |
| .0005 | .0127 | 3 |
| .001 | .0254 | 1 |

*Values truncated

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

NOTE: Refer to performance curves on page 109 for codes S, 3, 1

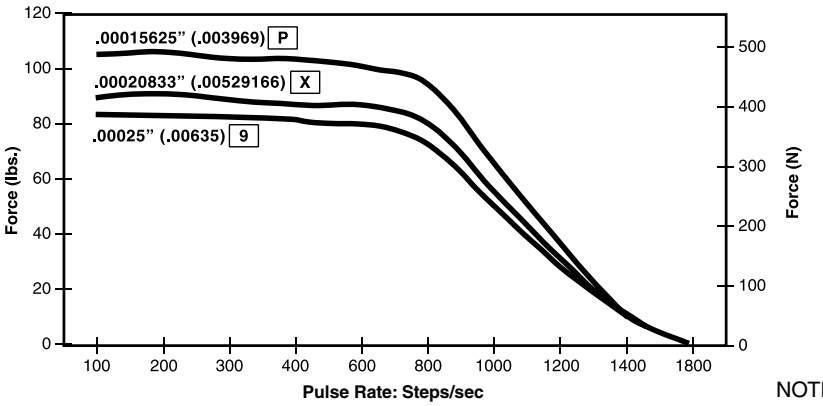
† Part numbering information on page 107.

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

### *FORCE vs. PULSE RATE*

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

– with two available lead-screw diameters

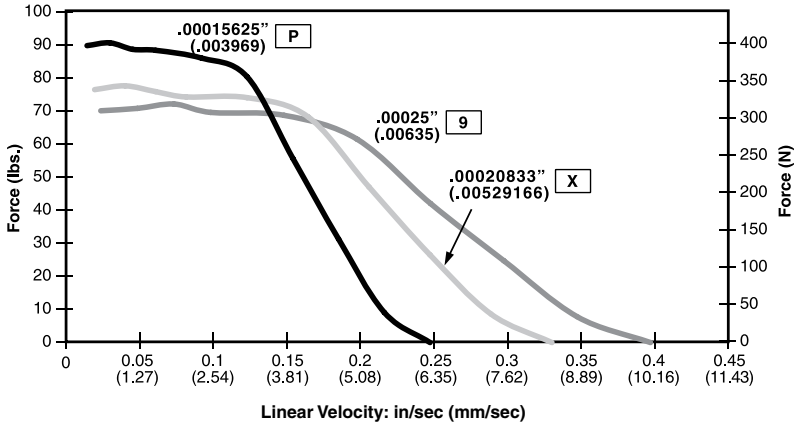



NOTE: All chopper drive curves were created with a 5 volt motor and a 75 volt power supply.

### *FORCE vs. LINEAR VELOCITY*

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

– with two available lead-screw diameters




Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

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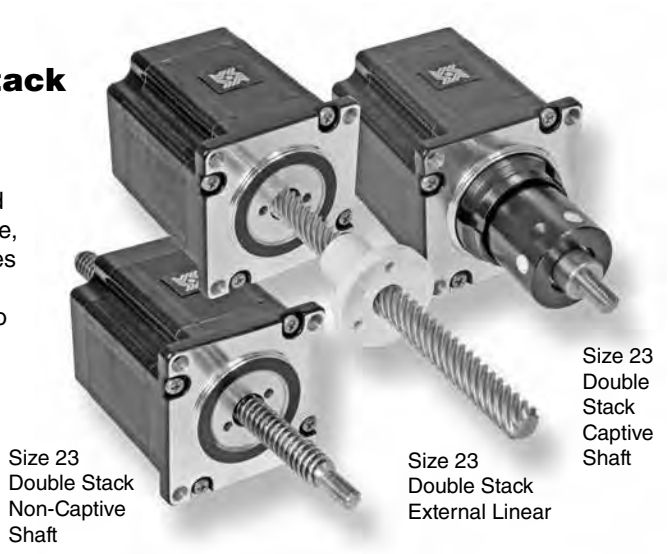
## Haydon® 57000 Series Size 23 Double Stack hybrid linear actuators deliver greater performance in a compact size.

The various patented designs deliver exceptional performance and new linear motion design opportunities. Three designs are available, captive, non-captive and external linear versions. The 57000 Series is available in a wide variety of resolutions - from 0.0005-in (.0127 mm) per step to 0.005-in (.127 mm) per step. The motors can also be microstepped for even finer resolutions. The Size 23 actuator delivers thrust of up to 200 lbs. (890 N).




## Specifications

| Size 23: 57 mm (2.3-in) Double Stack Hybrid Linear Actuator (1.8° Step Angle) | | | | |
|---|---|---|---|---|
| Part No. | Captive | 57M4 ■–■■–■■■ | | |
| | Non-captive | 57L4 ■–■■–■■■ | | |
| | External Lin. | E57M4 ■–■■–■■■ | | |
| Wiring | | Bipolar | | |
| Winding Voltage | | 3.25 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 3.85 A | 2.5 A | 1 A |
| Resistance/phase | | 0.98 Ω | 2.0 Ω | 12.0 Ω |
| Inductance/phase | | 2.3 mH | 7.6 mH | 35.0 mH |
| Power Consumption | | 25 W Total | | |
| Rotor Inertia | | 332 gcm² | | |
| Insulation Class | | Class B (Class F available) | | |
| Weight | | 32 oz (958 g) | | |
| Insulation Resistance | | 20 MΩ | | |

| Linear Travel / Step Screw Ø.375" (9.53 mm) inches | mm | Order Code I.D. |
|---|---|---|
| .0005 | .0127* | 3 |
| .001 | .0254 | 1 |
| .002 | .0508 | 2 |
| .0025 | .0635 | Y |
| .005 | .127 | Z |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.



## *Identifying the Hybrid part number codes when ordering*

**E** – **57** – **M** – **4** – **3** – **3.25** – **910**

***Prefix***
(include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**57 = 57000**

(Series numbers represent approximate width of motor body)

***Style***

**L** = 1.8° Non-captive
**M** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)

***Code ID Resolution Travel/Step***

**3** = .0005-in (.0127)
**1** = .001-in (.0254)
**2** = .002-in (.0508)
**Y** = .0025-in (.0635)
**Z** = .005-in (.127)

***Voltage***

**3.25** = 3.25 VDC
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 112.)*

***Suffix also represents:***

*–800 = Metric*

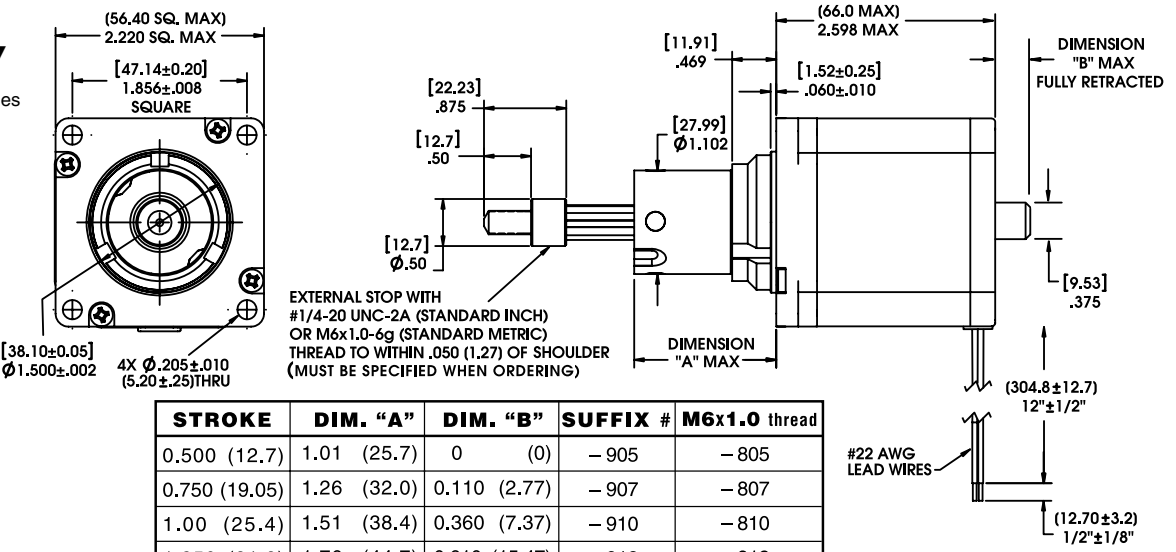
*–900 = External Linear with grease and flanged nut*

*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

## Captive Lead-screw

Dimensions = (mm) inches

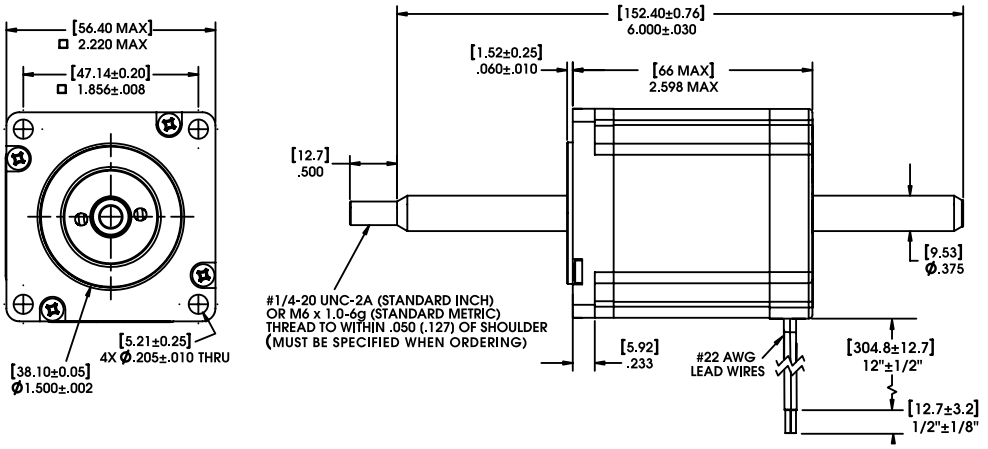



| STROKE | DIM. "A" | DIM. "B" | SUFFIX # | M6x1.0 thread |
|---|---|---|---|---|
| 0.500 (12.7) | 1.01 (25.7) | 0 (0) | – 905 | – 805 |
| 0.750 (19.05) | 1.26 (32.0) | 0.110 (2.77) | – 907 | – 807 |
| 1.00 (25.4) | 1.51 (38.4) | 0.360 (7.37) | – 910 | – 810 |
| 1.250 (31.8) | 1.76 (44.7) | 0.610 (15.47) | – 912 | – 812 |
| 1.500 (38.1) | 2.01 (51.1) | 0.860 (21.83) | – 915 | – 815 |
| 2.00 (50.8) | 2.51 (63.8) | 1.360 (34.52) | – 920 | – 820 |
| 2.500 (63.5) | 3.01 (76.5) | 1.860 (47.22) | – 925 | – 825 |

## Non-Captive Lead-screw

Dimensions = (mm) inches

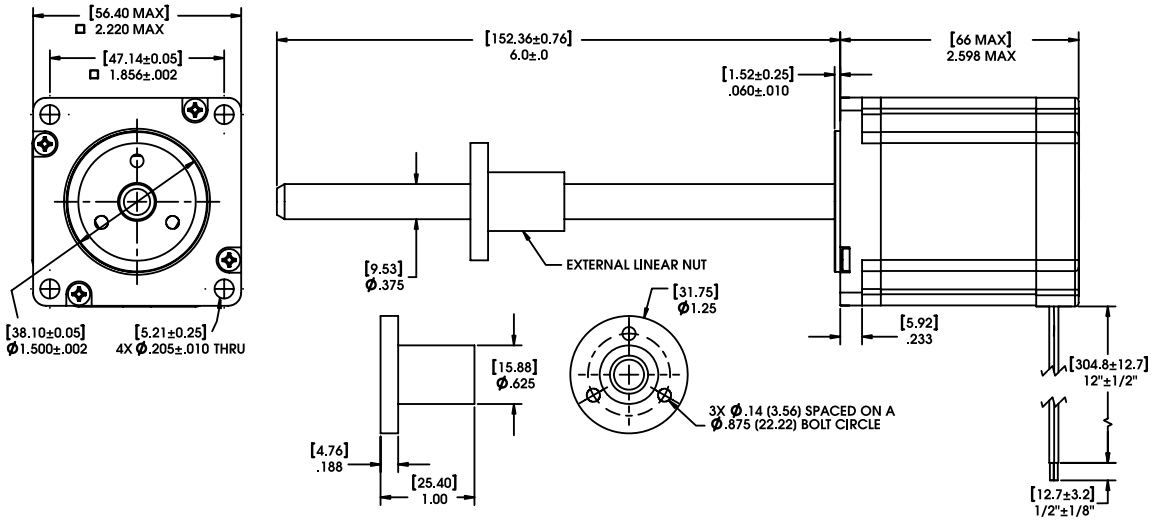
Up to 18-in (457 mm) standard screw lengths. Longer screw lengths are available.




## External Linear

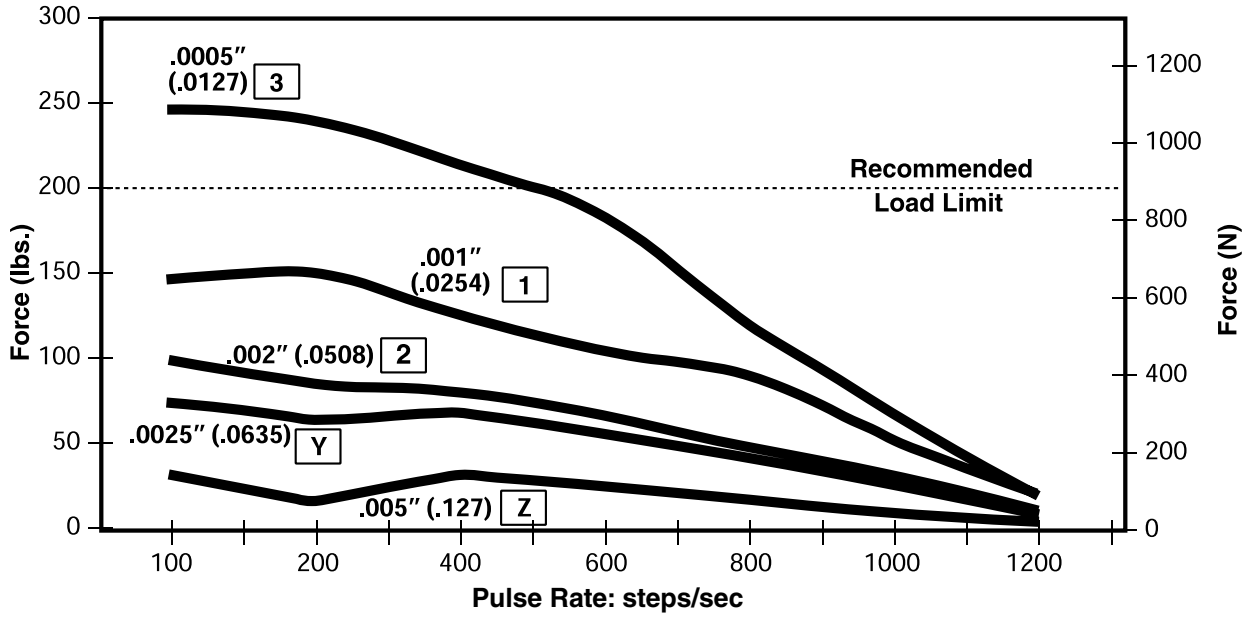
Dimensions = (mm) inches

Up to 12-in (305 mm) standard screw lengths. Longer screw lengths are available.



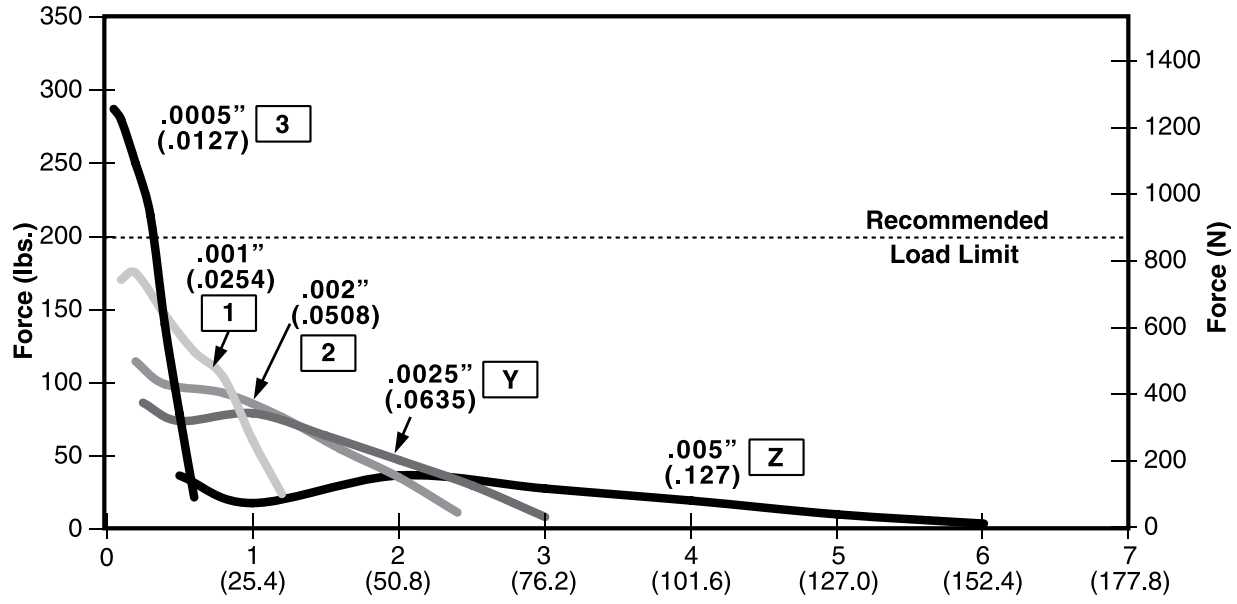
## FORCE vs. PULSE RATE

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .375 (9.53) Lead-screw**




## FORCE vs. LINEAR VELOCITY

**Chopper • Bipolar • 100% Duty Cycle • 8:1 Motor Coil to Drive Supply Voltage**
**Ø .375 (9.53) Lead-screw**




NOTE: All chopper drive curves were created with a 5 volt motor and a 75 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

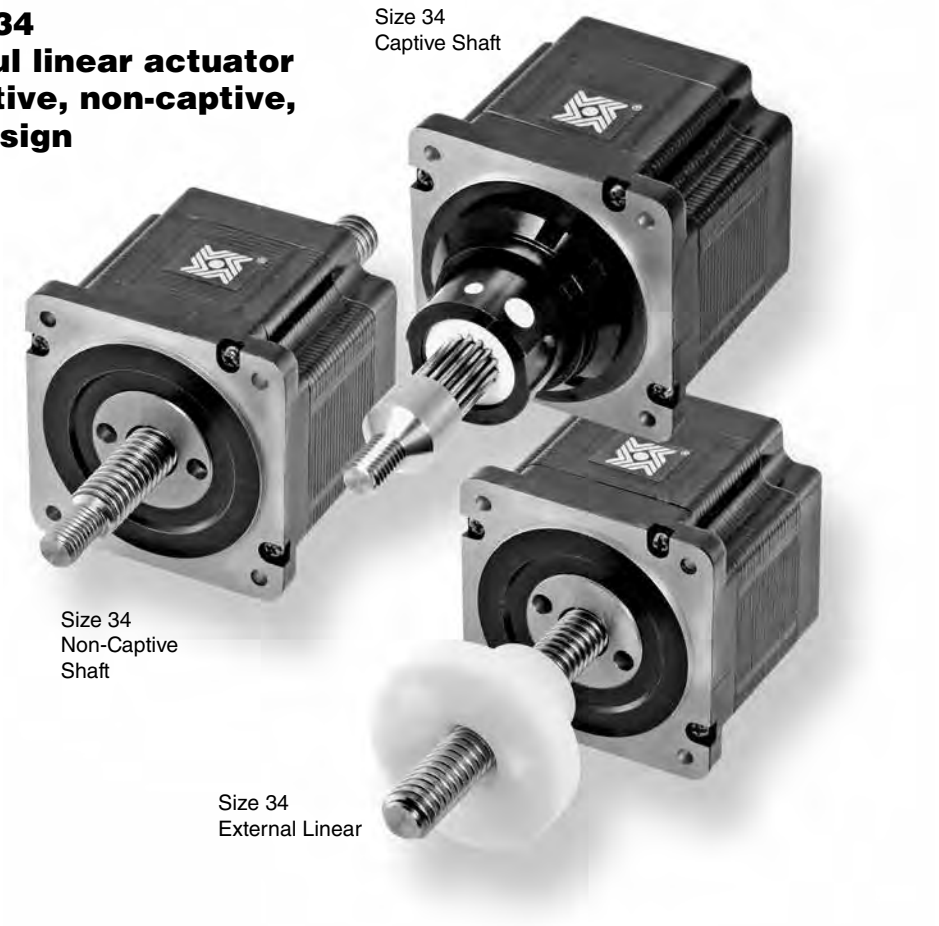
With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

## Haydon® 87000 Series Size 34 ... our largest, most powerful linear actuator is also available with a captive, non-captive, and external linear shaft design

Despite its large size and strength, this motor incorporates the same precision, high performance and durable patented designs featured in our entire hybrid product line. The 87000 series delivers forces up to 500 lbs. (2224 N) in a compact, 3.4-in (87 mm) square package.

The 87000 Series is available in a wide variety of resolutions - from 0.0005-in (.0127 mm) per step to 0.005-in (.127 mm) per step. Speeds exceed 3.0-in (7.62 cm) per second.

In addition to our standard configurations, Haydon Kerk Motion Solutions, Inc. can custom build this powerful motor to meet your specific motion requirements.




## Specifications

| **Size 34: 87 mm (3.4-in) Hybrid Linear Actuator** (1.8° Step Angle) | | | | | | |
|---|---|---|---|---|---|---|
| Part No. | Captive | 87H4 ■–■■–■■■† | | | 87H6 ■–■■–■■■† | |
| | Non-captive | 87F4 ■–■■–■■■† | | | 87F6 ■–■■–■■■† | |
| | External Lin. | E87H4 ■–■■–■■■† | | | E87H6 ■–■■–■■■† | |
| Wiring | | Bipolar | | | Unipolar** | |
| Winding Voltage | | 2.85 VDC | 5 VDC | 12 VDC | 5 VDC | 12 VDC |
| Current (RMS)/phase | | 5.47 A | 3.12 A | 1.3 A | 3.12 A | 1.3 A |
| Resistance/phase | | 0.52 Ω | 1.6 Ω | 9.23 Ω | 1.6 Ω | 9.23 Ω |
| Inductance/phase | | 2.86 mH | 8.8 mH | 51 mH | 4.4 mH | 25.5 mH |
| Power Consumption | | 31.2 W | | | | |
| Rotor Inertia | | 1760 gcm$^2$ | | | | |
| Insulation Class | | Class B (Class F available) | | | | |
| Weight | | 5.1 lbs. (2.3 Kg) | | | | |
| Insulation Resistance | | 20 MΩ | | | | |

| **Linear Travel / Step** Screw Ø.625"(15.88 mm) inches | mm | **Order Code I.D.** |
|---|---|---|
| .0005 | .0127 | 3 |
| .000625 | .0158* | B |
| .00125 | .0317* | C |
| .0025 | .0635 | Y |
| .005 | .127 | Z |

*Values truncated

Standard motors are Class B rated for maximum temperature of 130°C.

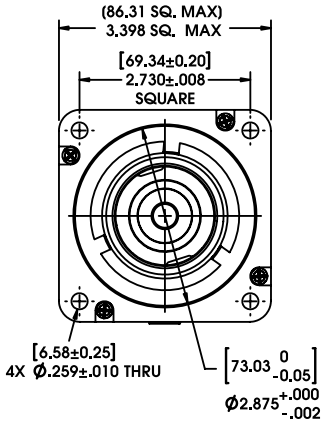
Special drive considerations may be necessary when leaving shaft fully extended or fully retracted.

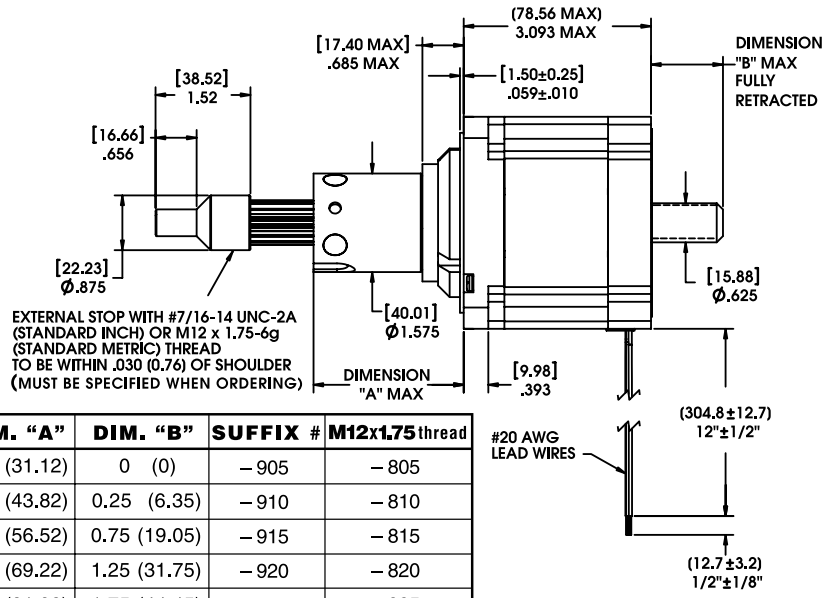
† Part numbering information on page 116.

** Unipolar drive gives approximately 30% less thrust than bipolar drive.

## Captive Lead-screw

Dimensions = (mm) inches



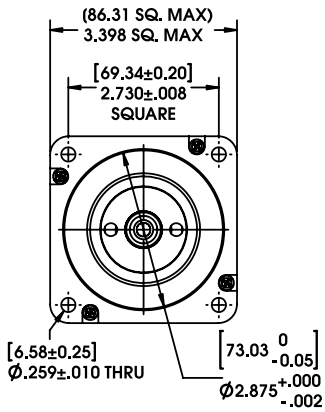



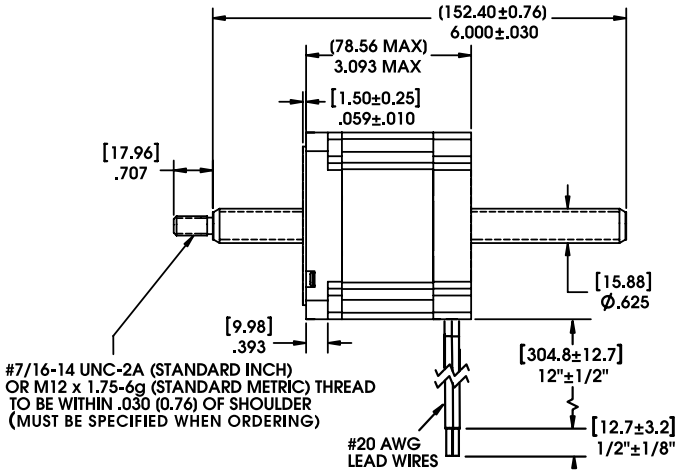

| STROKE | DIM. "A" | DIM. "B" | SUFFIX # | M12x1.75 thread |
|---|---|---|---|---|
| 0.50 (12.7) | 1.225 (31.12) | 0 (0) | – 905 | – 805 |
| 1.00 (25.4) | 1.725 (43.82) | 0.25 (6.35) | – 910 | – 810 |
| 1.50 (38.1) | 2.225 (56.52) | 0.75 (19.05) | – 915 | – 815 |
| 2.00 (50.8) | 2.725 (69.22) | 1.25 (31.75) | – 920 | – 820 |
| 2.50 (63.5) | 3.225 (81.92) | 1.75 (44.45) | – 925 | – 825 |

## Non-Captive Lead-screw

Dimensions = (mm) inches

Up to 18-in (457 mm) standard screw lengths. Longer screw lengths are available.

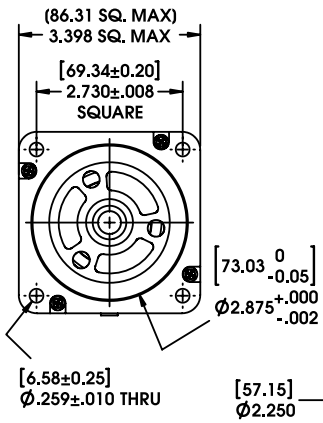



## External Linear

Dimensions = (mm) inches

Up to 12-in (305 mm) standard screw lengths. Longer screw lengths are available.



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## Identifying the Hybrid part number codes when ordering

| E | 87 | H | 4 | C | – | 2.85 | – | 910 |
|---|---|---|---|---|---|---|---|---|

***Prefix*** (include only when using the following)

**A** = A Coil (See AC Synchronous page 189)
**E** = External
**K** = External with 40° thread form
**P** = Proximity Sensor
**S** = Home Switch

***Series number designation***

**87 = 87000**

(Series numbers represent approximate width of motor body)

***Style***

**F** = 1.8° Non-captive
**H** = 1.8° Captive or External (use "E" or "K" Prefix for External version)

***Coils***

**4** = Bipolar (4 wire)
**6** = Unipolar (6 wire)

***Code ID Resolution Travel/Step***

**3** = .0005-in (.0127)
**B** = .000625-in (.0158)
**C** = .00125-in (.0317)
**Y** = .0025-in (.0635)
**Z** = .005-in (.127)

***Voltage***

**2.85** = 2.85 VDC
**05** = 5 VDC
**12** = 12 VDC

*Custom V available*

***Suffix***

***Stroke***
*Example: –910 = 1-in (Refer to Stroke chart on Captive motor series product page 115.)*

***Suffix also represents:***

*–800 = Metric*

*–900 = External Linear with grease and flanged nut*

*–XXX* = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

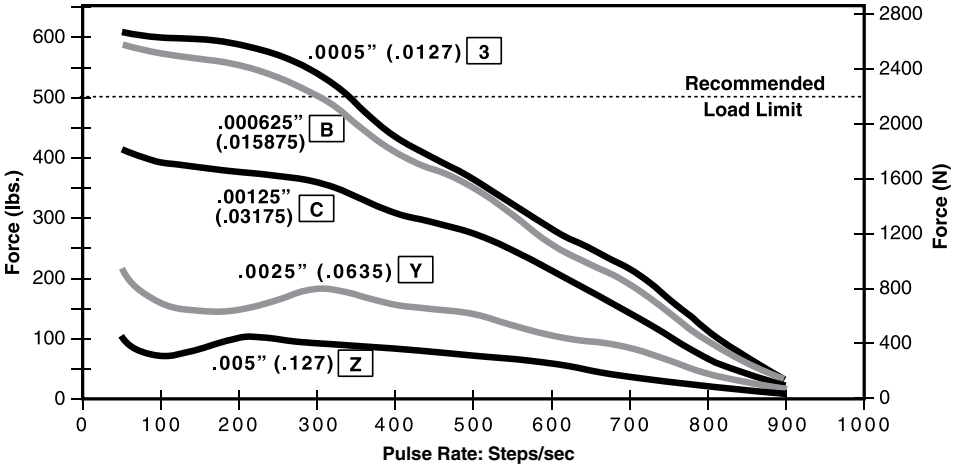
Haydon Kerk Express℠
www.HaydonKerkExpress.com
Standard products available 24-hrs.

## 87000 Series: Size 34 Single Stack Stack Performance Curves

### FORCE vs. PULSE RATE

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

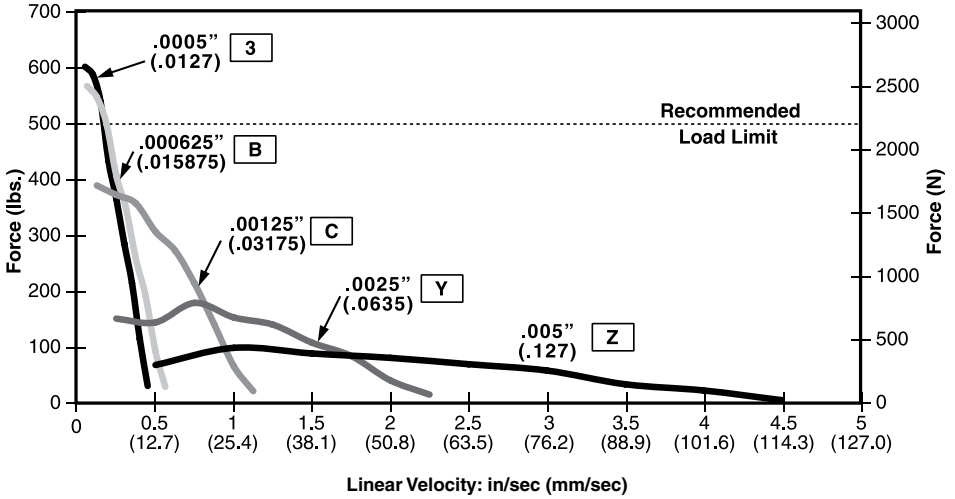
**Ø .625 (15.88) Lead-screw >**




### FORCE vs. LINEAR VELOCITY

- **Chopper**
- **Bipolar**
- **100% Duty Cycle**
- **8:1 Motor Coil to Drive Supply Voltage**

**Ø .625 (15.88) Lead-screw >**




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

# Integrated Connectors for Series 28000, 35000 and 43000 Hybrid Stepper Motor Linear Actuators

**Motor Connector:**
**JST part # S06B-PASK-2**
**Mating Connector:**
**JST part # PAP-06V-S**
**Haydon Kerk Part #56-1210-5 (12 in. Leads)**
**Wire to Board Connector:**
**JST part number SPHD-001T-P0.5**

| Pin # | Bipolar | Unipolar | Color |
|---|---|---|---|
| 1 | Phase 2 Start | Phase 2 Start | G/W |
| 2 | Open | Phase 2 Common | – |
| 3 | Phase 2 Finish | Phase 2 Finish | Green |
| 4 | Phase 1 Finish | Phase 1 Finish | R/W |
| 5 | Open | Phase 1 Common | – |
| 6 | Phase 1 Start | Phase 1 Start | Red |

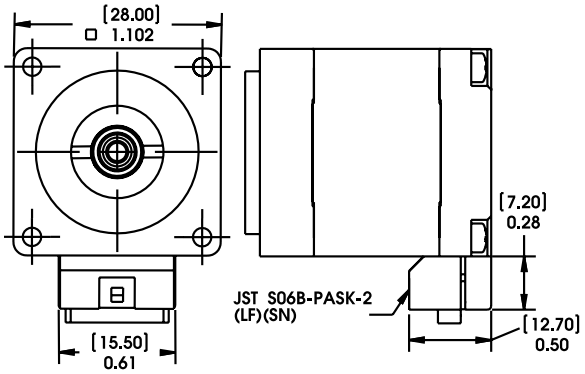
43000 Series, Size17 captive with integrated conector

Hybrid Sereies 28000, 35000 and 43000 (Size 11, 14, and 17) linear actuators are available with an integrated connector. Offered alone or with a harness assembly, this connector is RoHS compliant and features a positive latch in order for high connection integrity. The connector is rated up to 3 amps and the mating connector will handle a range of wire gauges from 22 to 28. This motor is ideal for those that want to plug in directly to pre-existing harnesses.

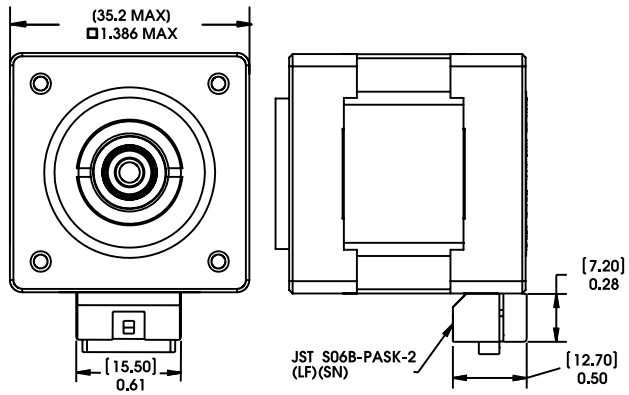
## *Integrated Connectors: Dimensional Drawings*

Dimensions = (mm) inches

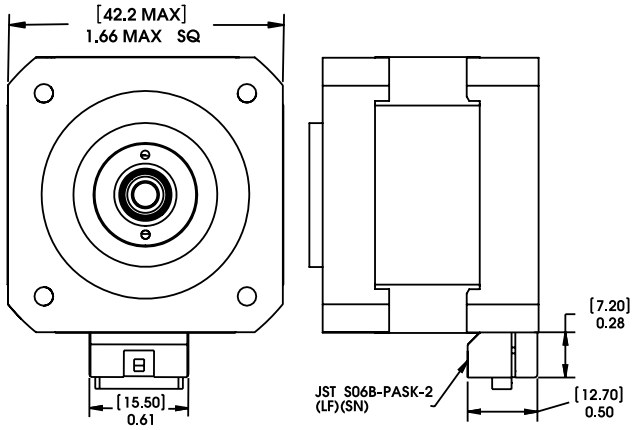
### 28000 Series: Size 11 Integrated Connector




### 35000 Series: Size 14 Integrated Connector




### 43000 Series: Size 17 Integrated Connector



# Encoders designed for all sizes of hybrid linear actuators: Series 21000, 28000, 35000, 43000, 57000 and 87000

Size 8 with encoder

All Haydon® hybrid linear actuators are available with specifically designed encoders for applications that require feedback. The compact optical incremental encoder design is available with two channel quadrature TTL squarewave outputs. An optional index is also available as a 3rd channel. The Size 8 encoder provides resolutions for applications that require 250 and 300 counts per revolution. The Size 11, 14 and 17 encoder provides resolutions for applications that require 200, 400 and 1,000 counts per revolution. The Size 23 and 34 encoder is offered in resolutions of 200, 400, 1,000 and 2,000 counts per revolution. Encoders are available for all motor configurations – captive, non-captive and external linear.

Size 17 with encoder

Simplicity and low cost make the encoders ideal for both high and low volume motion control applications. The internal monolithic electronic module converts the real-time shaft angle, speed, and direction into TTL compatible outputs. The encoder module incorporates a lensed LED light source and monolithic photodetector array with signal shaping electronics to produce the two channel bounceless TTL outputs.

Size 23 with encoder

### Electrical Specifications

| | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|
| Input voltage | 4.5 | 5.0 | 5.5 | VDC |
| Output signals | 4.5 | 5.0 | 5.5 | VDC |

- 2 channel quadrature TTL squarewave outputs.
- Channel B leads A for a clockwise rotation of the rotor viewed from the encoder cover.
- Tracks at speeds of 0 to 100,000 cycles/sec.
- Optional index available as a 3rd channel (one pulse per revolution).

### Operating Temperature

| Size 8 | |
|---|---|
| **Minimum** | - 10°C (14°F) |
| **Maximum** | 85°C (185°F) |

| Size 11, 14, 17, 23, 34 | |
|---|---|
| **Minimum** | - 40°C (- 40°F) |
| **Maximum** | 100°C (212°F) |

### Single Ended Encoder Pinout Size 8

| Connector Pin # | Description |
|---|---|
| 1 | +5 VDC Power |
| 2 | Channel A |
| 3 | Ground |
| 4 | Channel B |

### Single Ended Encoder Pinout Size 11, 14, 17 23, 34

| Connector Pin # | Description |
|---|---|
| 1 | Ground |
| 2 | Index (optional) |
| 3 | Channel A |
| 4 | +5 VDC Power |
| 5 | Channel B |

### Mechanical Specifications

| | Maximum |
|---|---|
| Acceleration | 250,000 rad/sec$^2$ |
| Vibration (5 Hz to 2 kHz) | 20 g |

### Differential Ended Encoder Pinout Size 11, 14, 17 23, 34

| Connector Pin # | Description |
|---|---|
| 1 | Ground |
| 2 | Ground |
| 3 | – Index |
| 4 | + Index |
| 5 | Channel A – |
| 6 | Channel A + |
| 7 | +5 VDC Power |
| 8 | +5 VDC Power |
| 9 | Channel B – |
| 10 | Channel B + |

**Resolution** 4 standard Cycles Per Revolution **(CPR)** or *Pulses Per Revolution* ***(PPR)***

**Size 8 Encoder**

| **CPR** | 250 | 300 |
|---|---|---|
| ***PPR*** | *1000* | *1200* |

**Others are available.**

**Size 11, 14 & 17 Encoders**

| **CPR** | 200 | 400 | 1000* |
|---|---|---|---|
| ***PPR*** | *800* | *1600* | *4000** |

**Size 23 and 34 Encoders**

| **CPR** | 200 | 400* | 1000 | 2000 |
|---|---|---|---|---|
| ***PPR*** | *800* | *1600** | *4000* | *8000* |

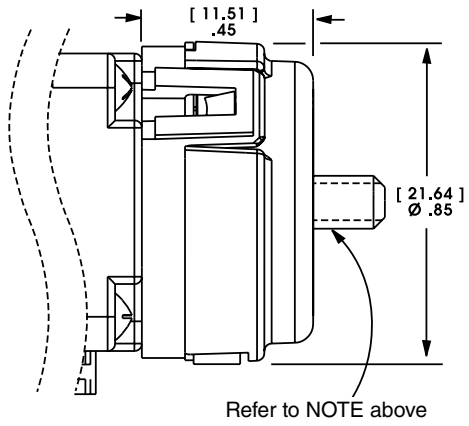
*Index Pulse Channel not available.

# Hybrid Encoders: Dimensional Drawings

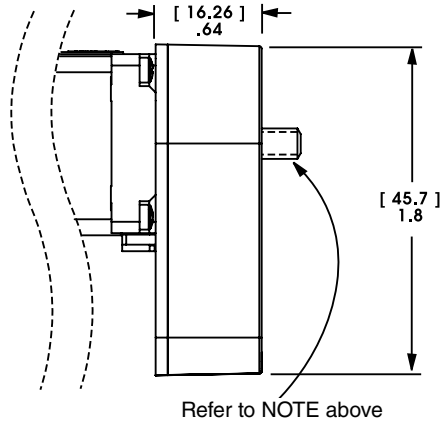
NOTE: Lead-screw extends beyond encoder on specific captive and non-captive motors.
External linear shaft extension is available upon request.

Dimensions = [ mm ] / inches

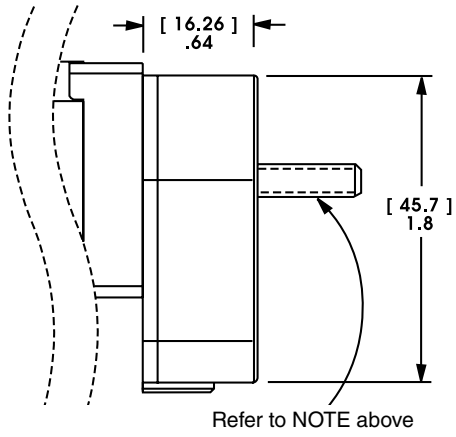
### 21 mm with 21000 Series Size 8



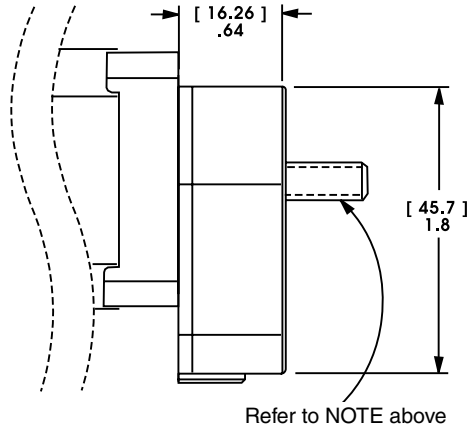

### 30 mm with 28000 Series Size 11



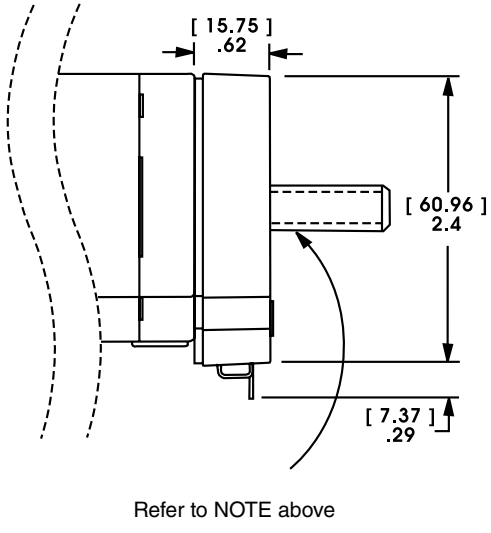

### 30 mm with 35000 Series Size 14



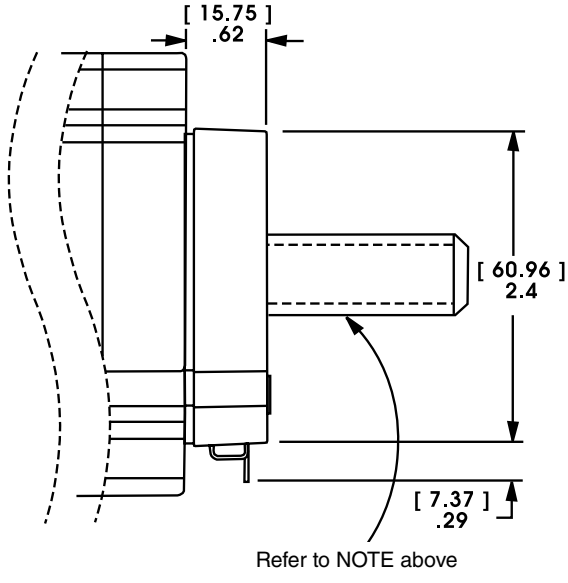

### 30 mm with 43000 Series Size 17




### 57 mm with 57000 Series Size 23




### 57 mm with 87000 Series Size 34



## Encoder Ready Option for all sizes of Hybrids

Haydon Hybrid Linear Actuators can now be manufactured as an encoder ready actuator. These encoder ready actuators can be used to install several popular hollow shaft encoders. They are available with an extended rotor journal and a threaded rear housing. The motors use a proprietary manufacturing process which incorporates engineering thermoplastics in the rotor drive nut and a stainless steel Acme lead-screw that allows the motor to be much more efficient and durable than today's more commonly used V-thread/bronze nut configurations.

## Extended Rotor Journal for all Hybrid sizes

Haydon Hybrid Linear Actuators are available with an extended rotor journal. This extended rotor journal can be used for encoder installation, manual adjustment, or flag installation for a positioning sensor.

## Size 23 Mounting Face Plate for Size 17 Hybrids

Haydon Kerk Motion Solutions, Inc. offers a Size 23 mounting pattern for its hybrid 43000 Series, Size 17 linear actuators.

## Home Position Switch for Hybrids

A miniature electronic home position switch capable of monitoring the home positions of linear actuators. The switch mounts on the rear sleeve of captive linear motors and allows the user to identify start, stop or home postions. When ordering motors with the home position switch, the part number should be preceded by an "S" prefix.

## End of Stroke Proximity Sensor for all sizes of Hybrids

The sensor incorporates a hall effect device, which is activated by a rare earth magnet embedded in the end of the internal screw. The compact profile of the sensor allows for installation in limited space applications.

The sensor has virtually unlimited cycle life. Special cabling and connectors can also be provided. When ordering motors with the proximity sensor, the part number should be preceded by a "P" prefix.

## Black Ice® and Kerkote® TFE Coated Lead-screws (certain conditions apply)

Where applications require the use of a "greaseless" screw and nut interface Haydon Kerk Motion Solutions offers TFE coated lead-screws.

A "dry" (non-lubricated) TFE coated lead-screw provides improved performance in both life and thrust as compared to a conventional stainless steel lead-screw. TFE can be applied to a wide variety of lead-screw pitches and is available for Haydon® brand captive, non-captive and external linear linear actuators.

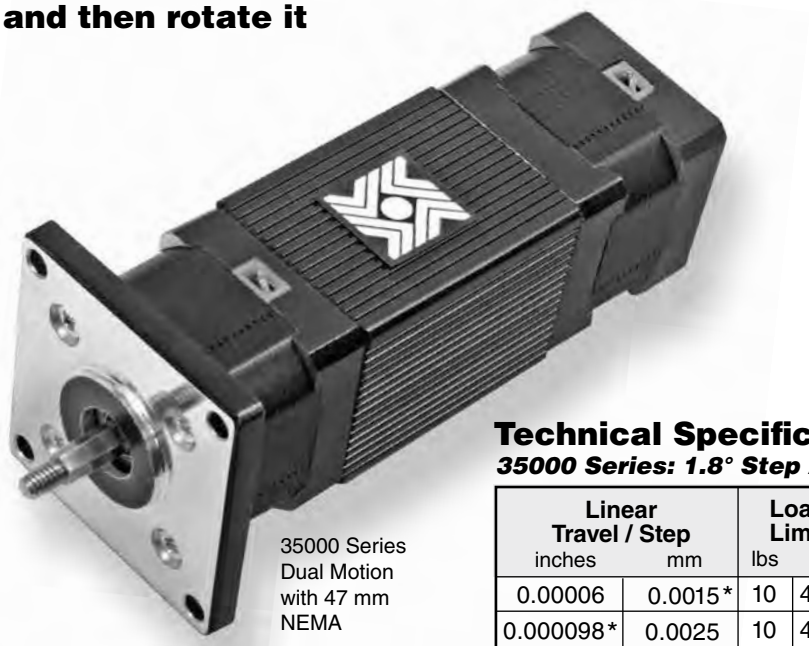
## Integrated Anti-backlash Nut for Hybrids

All sizes (except 87000 Series, Size 34) of captive and non-captive hybrid stepper motors can be equipped with an integral anti-backlash feature.

There is a normal backlash between the lead-screw and integral rotor nut. Haydon® actuators are designed for millions of cycles. However, over time additional backlash could increase and eventually double. Haydon Kerk Motion Solutions Integrated Anti-backlash nut can eliminate all backlash. Designed specifically for the Haydon captive and non-captive hybrid motors, these nuts use an opposing spring force to eliminate backlash between the screw and the nut interface. The nuts will self-compensate and accommodate any wear.

Haydon Kerk Motion Solutions application engineers can help you select the appropriate preload for your application.

## Haydon® Size 14 Dual Motion actuators axially move components to their insertion positions and then rotate it



35000 Series Dual Motion with 47 mm NEMA

The actuators are based on unique, patented designs and incorporate proven motor technology. These units simplify product development by replacing what would otherwise be far more bulky and complex mechanisms. Another feature of this design is to provide an electric motor in which linear and rotary motions are controllable independently of one another.

For a rotary/linear motor, it is desirable that the linear and rotary motions be controllable independently of one another. These devices can be run using a standard two axis stepper motor driver. Performance can be enhanced using chopper and/or microstepping drives.

## Technical Specifications

### *35000 Series: 1.8° Step Angle*

| Linear Travel / Step inches | Linear Travel / Step mm | Load Limit lbs | Load Limit N | Order Code I.D. |
|---|---|---|---|---|
| 0.00006 | 0.0015* | 10 | 44.4 | U |
| 0.000098* | 0.0025 | 10 | 44.4 | AA |
| 0.00012 | 0.0030* | 15 | 67 | N |
| 0.00019* | 0.005 | 15 | 67 | AB |
| 0.00024 | 0.0061* | 15 | 67 | K |
| 0.00039* | 0.01 | 15 | 67 | AC |
| 0.00048 | 0.0121* | 15 | 67 | J |
| 0.00078* | 0.02 | 15 | 67 | AD |
| 0.00157* | 0.04 | 15 | 67 | AE |

*Values truncated

### *35000 Series: 0.9° Step Angle*

| Linear Travel / Step inches | Linear Travel / Step mm | Load Limit lbs | Load Limit N | Order Code I.D. |
|---|---|---|---|---|
| 0.00003 | 0.00076* | 10 | 44.4 | BP |
| 0.00005* | 0.00125 | 10 | 44.4 | AY |
| 0.00006 | 0.0015* | 15 | 67 | U |
| 0.000098* | 0.0025 | 15 | 67 | AA |
| 0.00012 | 0.0030* | 15 | 67 | N |
| 0.00019* | 0.005 | 15 | 67 | AB |
| 0.00024 | 0.0061* | 15 | 67 | K |
| 0.00039* | 0.01 | 15 | 67 | AC |
| 0.00079* | 0.02 | 15 | 67 | AD |

Standard motors are Class B rated for maximum temperature of 130°C.



## *Identifying the Series 35000 Series dual motion part number codes when ordering*

| LR | 35 | H | H | 4 | J | – | 05 | – | 910 |
|---|---|---|---|---|---|---|---|---|---|

***Prefix***
**LR** = Linear/Rotary

***Series number designation***
**35 = 35000**

***Rotary Step Angle***
**H** = 1.8°
**K** = 0.9°
**M** = 1.8° Double Stack
**P** = 0.9° Double Stack

***Linear Step Angle***
**H** = 1.8°
**K** = 0.9°

***Coils***
**4** = Bipolar (4 wire)
**6** = Unipolar (6 wire)

***Code ID Resolution Travel/Step***

***1.8° Step Angle***
**U** = .00006-in (.0015)
**AA** = .000098-in (.0025)
**N** = .00012-in (.0030)
**AB** = .00019-in (.005)
**K** = .00024-in (.0061)
**AC** = .00039-in (.01)
**J** = .00048-in (.0121)
**AD** = .00078-in (.02)
**AE** = .00157-in (.04)

***0.9° Step Angle***
**BP** = .00003-in (.00076)
**AY** = .00005-in (.00125)
**U** = .00006-in (.0015)
**AA** = .000098-in (.0025)
**N** = .00012-in (.0030)
**AB** = .00019-in (.005)
**K** = .00024-in (.0061)
**AC** = .00039-in (.01)
**AD** = .00078-in (.02)

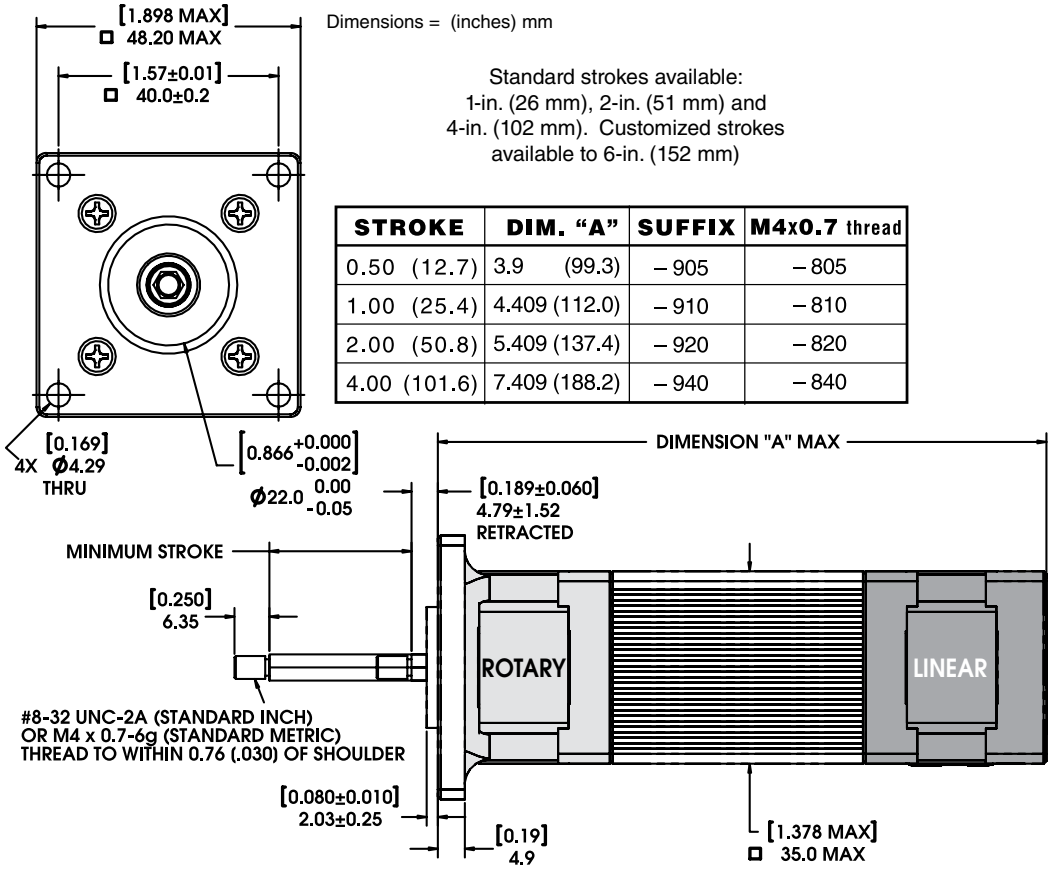
***Voltage***
**05** = 5 VDC
**12** = 7.5 VDC
**SP** = Mixed Voltages
*Custom V available*

***Suffix:***
***Stroke***
*Example: –910 = 1-in (26 mm)*
*–XXX = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.*

***NOTE:*** Dashes must be included in Part Number (–) as shown above. For assistance or order entry, call our engineering team at 203 756 7441.

NOTE: SEE PAGE 87
35000 SERIES HYBRID FOR MORE DETAILED MOTOR INFORMATION

## Dimensional Drawings



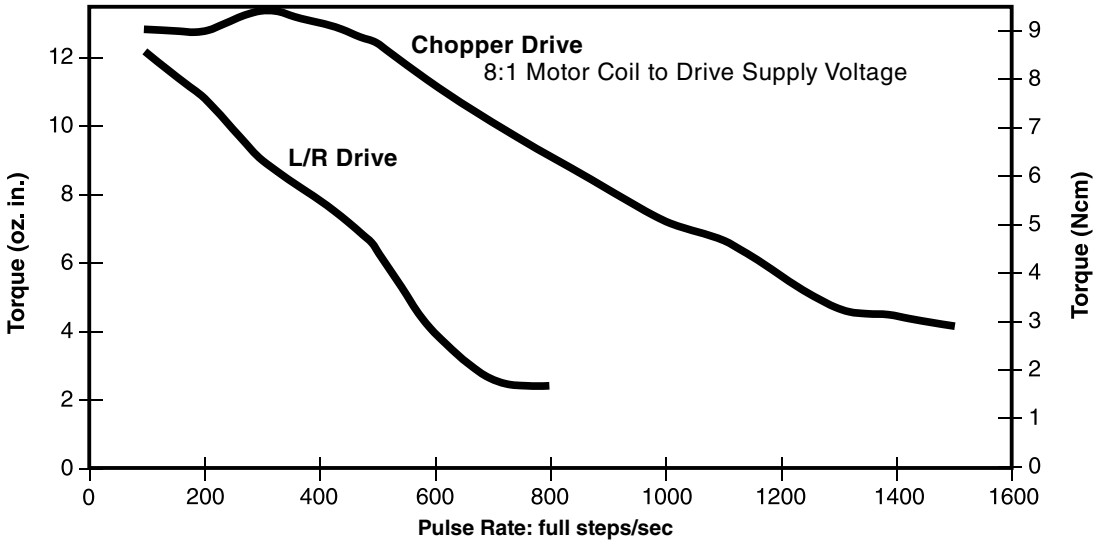

Standard strokes available:
1-in. (26 mm), 2-in. (51 mm) and
4-in. (102 mm). Customized strokes
available to 6-in. (152 mm)

| STROKE | DIM. "A" | SUFFIX | M4x0.7 thread |
|---|---|---|---|
| 0.50 (12.7) | 3.9 (99.3) | – 905 | – 805 |
| 1.00 (25.4) | 4.409 (112.0) | – 910 | – 810 |
| 2.00 (50.8) | 5.409 (137.4) | – 920 | – 820 |
| 4.00 (101.6) | 7.409 (188.2) | – 940 | – 840 |



## *TORQUE vs. PULSE RATE: ROTARY FUNCTION*

**Bipolar • 100% Duty Cycle**




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

Ramping can increase the performance of a motor either by increasing the top speed or getting a heavier load accelerated up to speed faster. Also, deceleration can be used to stop the motor without overshoot.

With L/R drives peak force and speeds are reduced, using a unipolar drive will yield a further 30% force reduction.

**Haydon Kerk Motion Solutions, Inc.** • www.haydonkerkpittman.com • Phone: 800 243 2715 • International: 203 756 7441

## Haydon® Size 17 dual motion actuators provide linear and rotary motions, controllable independently of one another

For a rotary/linear motor, it is desirable that the linear and rotary motions be controllable independently of one another. These devices can be run using a standard two axis stepper motor driver. Performance can be enhanced using chopper and/or microstepping drives.

The actuators are based on unique, patented designs and incorporate proven motor technology. These units simplify product development by replacing what would otherwise be far more bulky and complex mechanisms.

43000 Series
Dual Motion
with 57 mm NEMA

## *Identifying the 43000 Series Dual Motion part number codes when ordering*

| LR | 43 | H | H | 4 | J | – | 05 | – | 910 |
|---|---|---|---|---|---|---|---|---|---|

***Prefix***

**LR** =Linear/ Rotary

***Series number designation***

**43 = 43000**

***Rotary Step Angle***

**H** = 1.8°
**K** = 0.9°
**M** = 1.8° Double Stack
**P** = 0.9° Double Stack

***Linear Step Angle***

**H** = 1.8°
**K** = 0.9°

***Coils***

**4** = Bipolar (4 wire)
**6** = Unipolar (6 wire)

***Code ID Resolution Travel/Step***

***1.8° Step Angle***

**N** = .00012-in (.003)
**7** = .000125-in (.0031)
**P** = .00015625-in (.0039)
**AB** = .00019-in (.005)
**K** = .00024-in (.006)
**9** = .00025-in (.0063)
**A** = .0003125-in (.0079)
**AC** = .00039-in (.01)
**J** = .00048-in (.0121)
**3** = .0005-in (.0127)
**B** = .000625-in (.0158)
**AQ** = .00098-in (.025)
**Q** = .00096-in (.0243)
**C** = 0.00125-in (.0317)
**BH** = .00196-in (.05)
**R** = 0.00192-in (.0487)
**Y** = .0025-in (.0635)
**AG** = .00375-in (.0953)
**Z** = .005-in (.127)

***0.9° Step Angle***

**U** = .00006-in (.0015)
**BB** = .0000625-in (.0016)
**V** = .00007825-in (.00198)
**AA** = .000098-in (.0025)
**N** = .00012-in (.003)
**7** = .000125-in (.0031)
**P** = .00015625-in (.0039)
**AB** = .00019-in (.005)
**K** = .00024-in (.006)
**9** = .00025-in (.0063)
**A** = .0003125-in (.0079)
**BG** = .00049-in (.0125)
**J** = .00048-in (.0121)
**B** = .000625-in (.0158)
**AQ** = .00098-in (.025)
**Q** = .00096-in (.0243)
**C** = 0.00125-in (.0317)
**AF** = .001875-in (.0476)
**Y** = .0025-in (.0635)

***Voltage***

**05** = 5 VDC
**12** = 7.5 VDC
**SP** = Mixed Voltages

*Custom V available*

***Suffix:***

***Stroke***
*Example:*
*–910 = 1-in (26 mm)*

*–XXX = Proprietary suffix assigned to a specific customer application. The identifier can apply to either a standard or custom part.*

***NOTE:*** Dashes must be included in Part Number (–) as shown above.
For assistance or order entry, call our engineering team at 203 756 7441.

NOTE: SEE PAGE 95 43000 SERIES HYBRID FOR MORE DETAILED MOTOR INFORMATION

## Technical Specifications

### 43000 Series: 1.8° Step Angle

| Linear Travel / Step inches | Linear Travel / Step mm | Load Limit lbs | Load Limit N | Order Code I.D. |
|---|---|---|---|---|
| 0.00012 | 0.003* | 30 | 133 | N |
| 0.000125 | 0.0031* | 30 | 133 | 7 |
| 0.00015625 | 0.0039* | 30 | 133 | P |
| 0.00019* | 0.005 | 30 | 133 | AB |
| 0.00024 | 0.0060* | 30 | 133 | K |
| 0.00025 | 0.0063* | 30 | 133 | 9 |
| 0.0003125 | 0.0079* | 50 | 222 | A |
| 0.00039* | 0.01 | 50 | 222 | AC |
| 0.00048 | 0.0121* | 50 | 222 | J |
| 0.0005 | 0.0127* | 50 | 222 | 3 |
| 0.000625 | 0.0158* | 50 | 222 | B |
| 0.00098* | 0.025 | 50 | 222 | AQ |
| 0.00096 | 0.0243* | 50 | 222 | Q |
| 0.00125 | 0.0317* | 50 | 222 | C |
| 0.00196* | 0.05 | 50 | 222 | BH |
| 0.00192 | 0.0487* | 50 | 222 | R |
| 0.0025 | 0.0635 | 50 | 222 | Y |
| 0.00375 | 0.0953* | 50 | 222 | AG |
| 0.005 | 0.127 | 50 | 222 | Z |

*Values truncated

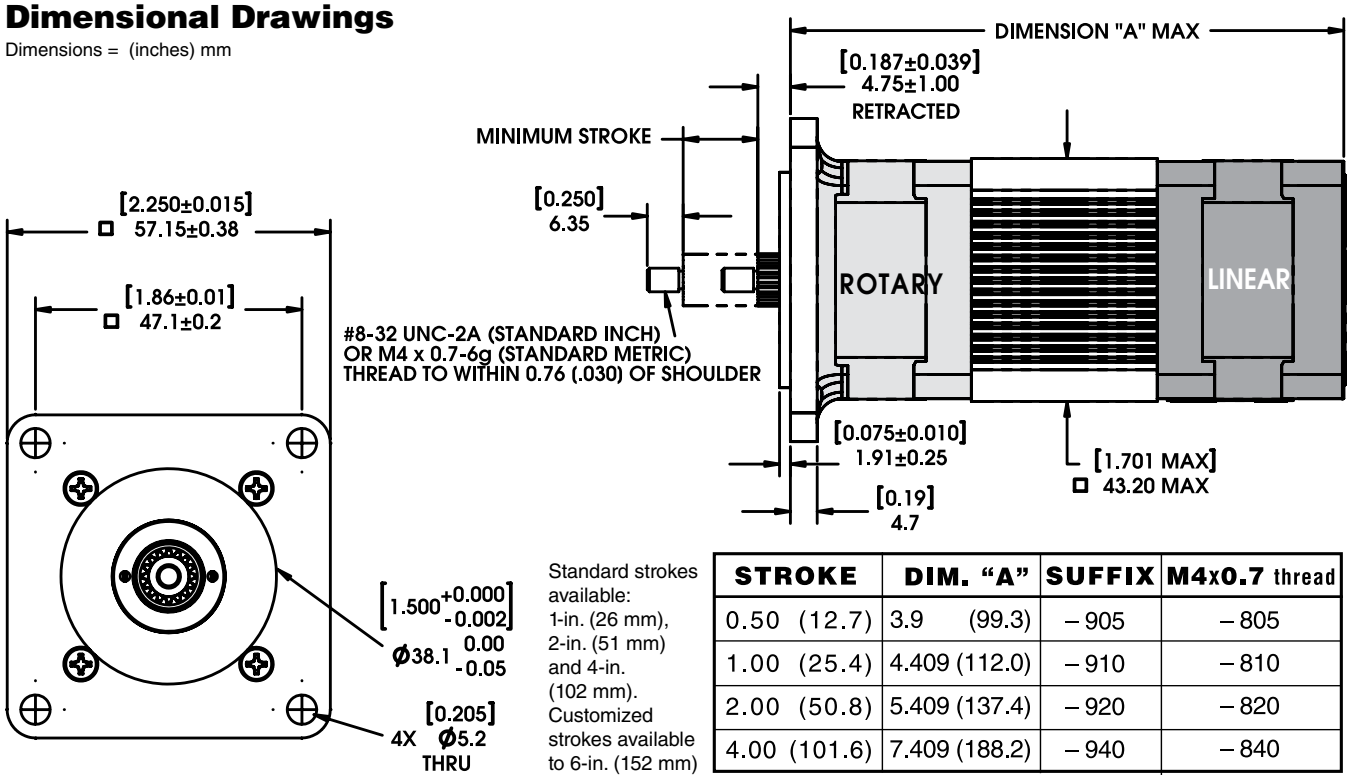
### 43000 Series: 0.9° Step Angle

| Linear Travel / Step inches | Linear Travel / Step mm | Load Limit lbs | Load Limit N | Order Code I.D. |
|---|---|---|---|---|
| 0.00006 | 0.0015* | 30 | 133 | U |
| 0.0000625 | 0.0016* | 30 | 133 | BB |
| 0.00007825 | 0.00198* | 30 | 133 | V |
| 0.000098* | 0.0025 | 30 | 133 | AA |
| 0.00012 | 0.003* | 30 | 133 | N |
| 0.000125 | 0.0031* | 30 | 133 | 7 |
| 0.00015625 | 0.0039* | 50 | 222 | P |
| 0.00019* | 0.005 | 50 | 222 | AB |
| 0.00024 | 0.0060* | 50 | 222 | K |
| 0.00025 | 0.0063* | 50 | 222 | 9 |
| 0.0003125 | 0.0079* | 50 | 222 | A |
| 0.00049* | 0.0125 | 50 | 222 | BG |
| 0.00048 | 0.0121* | 50 | 222 | J |
| 0.000625 | 0.0158* | 50 | 222 | B |
| 0.00098* | 0.025 | 50 | 222 | AQ |
| 0.00096 | 0.0243* | 50 | 222 | Q |
| 0.00125 | 0.0317* | 50 | 222 | C |
| 0.001875 | 0.0476* | 50 | 222 | AF |
| 0.0025 | 0.0635 | 50 | 222 | Y |

Standard motors are Class B rated for maximum temperature of 130°C.

## Dimensional Drawings

Dimensions = (inches) mm

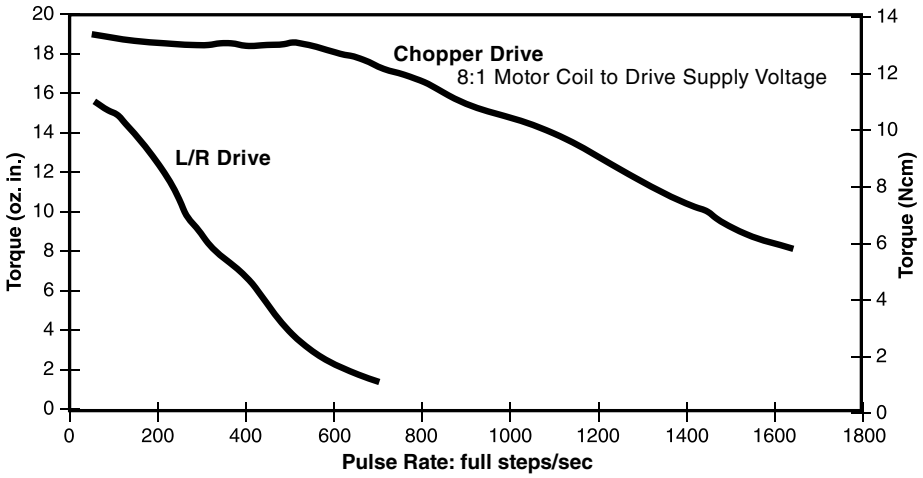



Standard strokes available: 1-in. (26 mm), 2-in. (51 mm) and 4-in. (102 mm). Customized strokes available to 6-in. (152 mm)

| STROKE | DIM. "A" | SUFFIX | M4x0.7 thread |
|---|---|---|---|
| 0.50 (12.7) | 3.9 (99.3) | – 905 | – 805 |
| 1.00 (25.4) | 4.409 (112.0) | – 910 | – 810 |
| 2.00 (50.8) | 5.409 (137.4) | – 920 | – 820 |
| 4.00 (101.6) | 7.409 (188.2) | – 940 | – 840 |

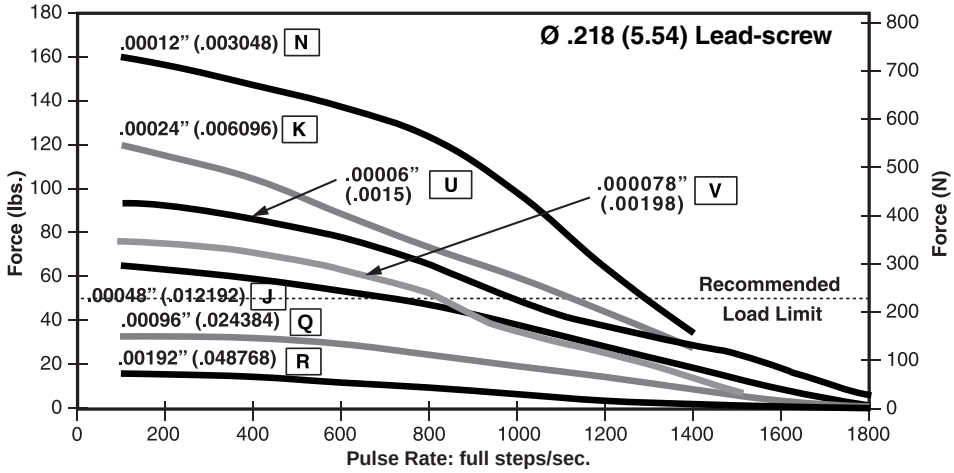
## TORQUE vs. PULSE RATE: ROTARY FUNCTION

- Bipolar
- 100% Duty Cycle



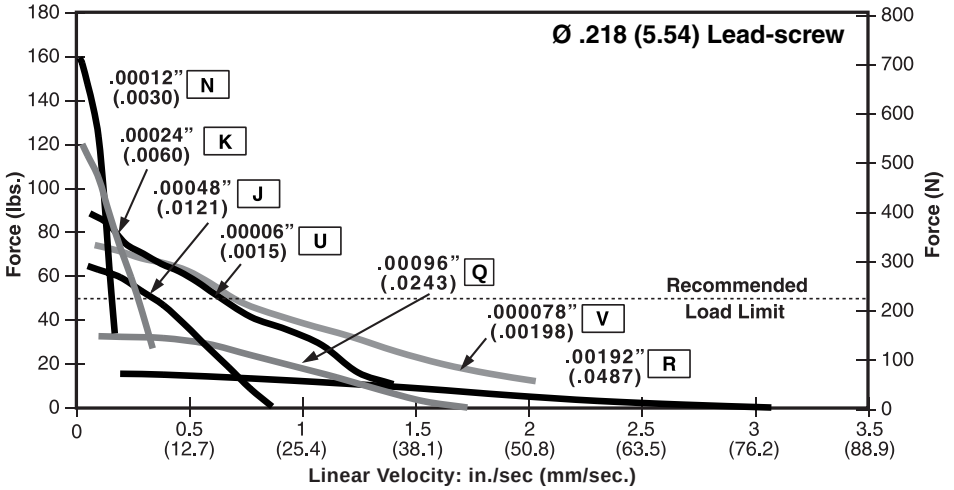

## FORCE vs. PULSE RATE: LINEAR FUNCTION

- Chopper
- Bipolar
- 100% Duty Cycle
- 8:1 Motor Coil to Drive Supply Voltage




## FORCE vs. LINEAR VELOCITY

- Chopper
- Bipolar
- 100% Duty Cycle
- 8:1 Motor Coil to Drive Supply Voltage




NOTE: All chopper drive curves were created with a 5 volt motor and a 40 volt power supply.

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